

THE
OUTLOOK OF SCIENCE
MODERN
MATERIALISM

by
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PREFACE

SINCE the present work first appeared, much has happened in the world of science. Recent discoveries with a direct bearing on modern materialism have been included in this second edition. Some non-essential material has been omitted in the course of revision, and a new introduction has been written. The chapter on modern physics in the first edition was read by Professor Planck, who kindly expressed his general agreement with the views presented. In the present edition, however, this chapter has been entirely rewritten in order to cover new ground. My thanks are due to Professor Ariëns Kappers, of the Institute for Brain Research, Amsterdam, who made a critical review of the original manuscript, stating that the fundamental ideas in most respects were also his own. I am grateful to Professor Einstein for his favourable criticism of the chapter on space and time. Mrs. M. Worrall gave the untiring help that enabled me to complete the work.

London, 1946

INTRODUCTION

MATERIALISTS, who do not share belief in the supernatural either with savages or scholars, are commonly accused of 'not believing in anything'. Materialism as a philosophy is allegedly destructive to all ideals, and is not infrequently confused with the sensual materialism of a self-seeking hedonist.

Linked with such misrepresentations of materialist philosophy is a loud 'lament in established institutions concerning the current lack of belief in traditional teachings. Science and war have smashed the stately edifice of nineteenth century ideology, leaving a 'waste land' on which the young gaze with a blend of cynicism and fascination. After a surfeit of bourgeois illusions, sheer disbelief has its own comforting if temporary attraction.

In the sixteenth century, during the disintegration of medieval ideology, a rebirth of intellectual thought entailed a rediscovery of classical philosophy. Today, the dry bones of classical philosophy are examined closely only by still more desiccated dons. Philosophy as a separate and systematic study is now largely the jealously guarded property of a few academic institutions; its function is not to explain but to exclude the world.

Though science has played a great part in producing this situation, science has not yet developed its own philosophy or general world outlook. Science is still mainly a method of dealing with individual phenomena, a logical approach to practical questions, a model technique for solving particular problems. Science does not yet compete with religion, or even with obsolete classical philosophy, in formulating the widest possible generalizations concerning man and the universe, or in answering the most profound questions concerning the simplest things. In short, the outlook of science is still in the main a technical outlook.

Yet some scientists at the present time are seriously endeavouring to broaden their outlook and deepen their knowledge beyond the confines of laboratory technique and mathematical method. This effort is no attempt to spin a philosophical system separate and distinct from scientific technique. On the contrary, this philosophical search springs from the soil of scientific research. Without deserting the factual ground of

observation and experiment, some scientists—and many more who follow science progress—are seeking a point of view high enough to overlook all barriers to limitless vision.

If dialectic materialism is to become the general world outlook of science, it must in some measure satisfy this search. Mere repetition of the abstract principles of materialist dialectics, or mere enumeration of known facts illustrating those principles, is a futile occupation reminiscent of medieval scholasticism. To fulfill its historical function, modern materialism must answer the highest needs of the human mind from a dynamic basis of advancing scientific knowledge.

From time to time, an outstanding generalization of a particular science has a direct and powerful influence on the general development of human thought. Darwin's method of selecting and interpreting certain biological facts gave a generalization of this kind, creating a popular philosophy of nature in the sense that it developed a new view of life on the part of millions of people. The following principles of dialectic materialism, which are the most general laws of nature and society, are beginning to have a similar effect.

The universe is matter in various forms of motion. Matter is the sum total of all physical qualities; that is, of all physical forms, states, processes, tendencies, relationships. Matter is self-motivated and everywhere continuous in the dynamic relations of its different structural forms. Physical change is the sum total of various forms of motion, integrated in an infinite variety of events and processes. Physical change occurs through the developing unity of opposite and interpenetrating qualities. Quantitative changes give rise to qualitative changes, and vice versa. Thought is a function of the brain, which is matter organized in the course of evolution as a highly complex structure of nerve cells. Mind reflects in perception the independently existing reality of the ever changing physical world.

An understanding of these principles unlocks many doors. The general principles of dialectic materialism are instruments for constructing specific formulae in every branch of science. Formulae, however, which represent immortal truth, do not behave like mortals. The most potent set of mathematical symbols is no substitute for any human hope. Algebraical equations do not in themselves hold human beings together in any kind of social solidarity. The intellectual appreciation of dialectic principles is a poor achievement without an

emotional assimilation of materialism as a world outlook—as a philosophy, if we may still use the word. ‘Grey is theory, but green is the eternal tree of life’.

How can one put into words the feelings that inspire materialist thought? And yet it has been done! It was the materialist poet Lucretius who once wrote:

- Then it be ours, with steady mind to grasp
The purport of the skies, the law behind
The wandering courses of the sun and moon;
The powers that govern every living thing.
But most, to see, with reasonable eyes
Of what the mind, of what the soul is made,
And what it is, in sickness or in sleep,
That makes us rise in terror and think we see
Dead men whose bones Earth bosomed long ago.

For centuries after Lucretius had ceased to sing the glories of the material universe, theologians persuaded men that earth was only a miserable anteroom to heaven, and that the body was only the sordid and temporary resort of the soul. ‘If matter starts as a “beggar”,’ said the scientist John Tyndall, ‘it is because the Jacobs of theology have deprived it of its birth-right’. Only now, with the decline of religion and the advance of science, are we beginning to see in matter—like John Tyndall—‘the promise and potency of every form and quality of life’.

Matter in the light of modern science is a multi-dimensional kaleidoscopic pattern of flying particles and ever changing physical fields, evolving systems of incandescent stars, crystalline solids supporting energy-transforming colloids, living structures throbbing with electrical rhythm. The wonder of such perpetual motion cannot be expressed in mere words; it requires the magic of Paganini’s music to convey a sense of this *perpetuum mobile*. Now and then a scientist of genius finds words to illustrate faintly the stupendous scene, as when Nikola Tesla said: ‘we are whirling through endless space . . . all around us everything is spinning, everything is moving, everywhere is energy. There must be some way of availing ourselves of this energy more directly . . . the mere contemplation of these magnificent possibilities expands our minds, strengthens our hopes and fills our hearts with supreme delight’.

A sense of unity with the evolving material universe, a wish to survive in some way through participating in that evolution, a social sympathy in harmony with such a wish—these are

some of the feelings that combine with a materialist understanding of nature and society. These feelings involve no invocation of imaginary supernatural agencies to allay anxiety about the unknown. Insight into the 'promise and potency' of matter makes the whole earth a home, human life an end in itself, and social endeavour a sufficient reason for individual existence.

Chapter I

SCIENCE, RELIGION AND PHILOSOPHY

¹ MATERIALISM AND SUBJECTIVE IDEALISM

PHILOSOPHICAL materialism is the system of thought which places matter, meaning the physical world or universe, in a primary position, and mind, meaning human thought in general, in a secondary position. The reason for this is that *matter, or the physical world, existed long before mind*, and even before living things. In this sense, therefore, matter is primary to mind. It is primary in so far as *mind is a derivative of matter*—of matter *organized* in a certain way, that is, of *organic matter*, the physical basis of life. In particular, mind is a product of the nervous system of an animal, and is dependent upon the nervous system, of which the brain is the most highly developed portion. We know that the effect of a drug, e.g. alcohol or opium, on the brain substance seriously interferes with the mind. We say that mind is a function of the brain, and recognize that damage to the central nervous system interferes with this function.

These truths are well known to scientists, and hundreds of facts can be brought forward in support of them. *Thus the facts of science form the core of modern materialism.*

What we call *dialectic materialism* maintains also that our minds give us pictures, or images, or copies of external reality—of the physical world—and that the mental images approximate to physical reality. Dialectic materialism holds that through our sense organs—eyes, ears, nose, tongue, together with the sensory nerves of the skin, muscles, and other bodily organs—we can gain mental images of the physical world. Of course, these copies are not *exact* representations of the physical world; also we know inaccuracies of observation are common, and that we may also have illusions. Nevertheless we are able to form approximately correct ideas about physical reality. *As we put our ideas into practice we learn how correct they are, and our knowledge approximates closer still to an exact representation of physical reality.*

The general outlook of dialectic materialism is shared by the majority of scientists, and indeed by all humanity, in a form known as 'naïve realism'. As Lenin points out: "The naïve realism

of any healthy person, who is not an inmate of an insane asylum, or in the school of the idealist philosophers, consists in this, that he believes reality, the environment and the things in it, to exist independently of his perception—independently of his conception of himself in particular, and of his fellow men in general . . . *The 'naïve' belief of mankind is consciously taken by materialism as the basis of its theory of knowledge* [1].

Although people are not always conscious of the significance and implications, or even of the existence, of their materialist point of view, they would certainly regard as absurd the opinion of anyone who asserted that the world existed only in his own mind. Yet this is the opinion put forward by subjective idealists, either openly or in a concealed form.

In opposition to materialism, the philosophy of idealism places mind primary to matter, and regards the physical world as a derivative of mind—as dependent on human consciousness, or on some abstract general 'Mind', or 'Idea', or 'Will'. There are many kinds of idealism, differing in minor ways. The major characteristic common to all is the primacy given to mind. The question of the relation of mind to matter, of which is primary and 'fundamental', is the real storm centre of philosophical controversies. Idealists may bicker among themselves, but the vital conflict is between materialists and idealists.

Subjective idealism is most clearly expounded in the writings of George Berkeley, Bishop of Cloyne, who flourished in the early part of the 18th century. According to Berkeley, the world does not exist apart from the human mind. Objects are 'collections of ideas,' or 'combinations of sensations.' Things exist only in being perceived (their *esse* is *percipi*—to be is to be perceived). Berkeley denied the 'absolute' existence of objects, meaning the existence of things apart from human perception. The following words are from his *Principles of Human Knowledge* (1710): 'It is evident to anyone who takes a survey of the *objects* of human knowledge, that they are either *ideas* actually imprinted on the senses, or else such as are perceived by attending to the passions and operations of the mind; or lastly, ideas formed by help of memory and imagination.

'A certain colour, taste, smell, figure and consistence having been observed to go together, are accounted one distinct thing, signified by the name (e.g. apple); . . .

'But, beside all that endless variety of ideas or objects of knowledge, there is likewise something which knows or perceives

them, and exercises divers operations, as willing, imagining, remembering, about them. This perceiving, active being is what I call mind, spirit, soul, or myself. By which words I do not denote any one of my ideas, but a thing entirely distinct from them, wherein they exist, or, which is the same thing, whereby they are all perceived—for the existence of an idea consists in its being perceived' . . .

'The table I write on I say exists, that is, I see and feel it, and if I were put out of my study I should say it existed—*meaning thereby that if I was in my study I might perceive it, or that some other spirit actually does perceive it* . . .'

'As to what is said of the absolute existence of unthinking things without any relation to their being perceived, that is to me perfectly unintelligible. Their *esse* is *percipi*, nor is it possible that they should have any existence out of the minds of thinking things which perceive them'.

'It is an opinion *strangely prevailing* amongst men, that houses, mountains, rivers, and in a word all sensible objects have an existence, natural or real, distinct from their being perceived by the understanding. . . .

'From what has been said it is evident that *there is not any other substance than spirit, or that which perceives* . . . there can be no unthinking substance, or substratum of those ideas' [2].

Berkeley's subjective idealism, carried to its logical conclusion, is *solipsism* (Latin *solus*, 'alone', 'only'; *ipse*, 'self'). Solipsism is the doctrine that nothing exists except in my own mind. 'The world is my idea', or 'my sensation'—this is the absurdity at which a subjective idealist inevitably arrives.

Modern subjective idealists present their philosophy in disguised forms, so as to give the impression that theirs is a 'new' philosophy, and does not include the preposterous conclusions of Berkleian idealism. Berkeley himself made some attempt to cover the idealistic nakedness of his philosophy, and to make it acceptable to 'common sense'. Fraser, who edited Berkeley's works, had the audacity to describe Berkeley's doctrine as 'Natural Realism'!

In trying to distinguish between the real and the fictitious, Berkeley connected the idea of reality with the simultaneous perception of the same sensations by different people. He wrote: 'If at the table all who were present should see, and smell, and taste, and drink wine, and find the effects of it, with me there

could be no doubts of its reality'. This quotation is found in Lenin's *Materialism and Empirio-criticism*; also Fraser's remark: 'The simultaneous consciousness of, or participation in, the "same" sense-ideas, by different persons, as distinguished from the purely individual or personal consciousness of imaginary objects and emotions, is here referred to (as) a test of the reality of the former' [3]. On this Lenin comments: 'It is evident that Berkeley's subjective idealism is not to be interpreted as if he ignored the distinction between individual and collective perception. On the contrary, on the basis of this distinction, he attempts to construct the criterion of reality. Inferring "ideas" from the divinity's effects upon human mind, Berkeley thus comes near to objective idealism: the world is not my idea, but it becomes the product of a supreme spiritual cause that creates the "laws of nature", and the laws for distinguishing "more real" ideas from those less real' [4].

It will be seen that the *objective*—the physical reality presented to our senses—becomes in Berkeley's philosophy identical with the *subjective*—with the similar perceptions of a number of people. This same opinion is found in the writings of modern subjective idealists. For example, we read in Bertrand Russell's *Analysis of Matter*: 'I mean here by "objective" not anything metaphysical, but merely "*agreeing with the testimony of others*"' [5]. Russell, like many other idealists, calls it 'metaphysical' to say that objects exist apart from human perceptions. By 'objective' he does not mean this, but merely 'agreeing with the testimony of others'. It is then only possible to explain this 'agreement' by divine direction from some supernatural agency. However, Russell, unlike Berkeley, does not call in God to deal with this difficulty, but leaves unexplained how the testimony of individual perceptions can agree without a corresponding independent physical reality.

Russell's attitude towards the real 'intrinsic' nature of the physical world is one of negation. He says: 'We know nothing of the intrinsic quality of the physical world, and therefore *do not know whether it is, or is not, very different from that of percepts*' [6]. This attitude is termed *agnosticism*.

2. AGNOSTICISM

Russell resembles other British idealists in wavering between idealism and agnosticism. The name 'agnosticism' was coined by Thomas Huxley about 1870 to express his philosophical attitude ('no knowledge') towards the real nature of the world. The agnostic admits the reality of the natural phenomena which he perceives, but refuses to admit that his perceptions give a true representation of what really exists in nature. He admits that our knowledge of the physical world comes to us through our senses, but denies that the senses can be relied upon to give a mental picture resembling the physical world. He may recognize that he possesses knowledge of certain qualities of a thing, but then denies knowledge (and even the possibility of knowledge) of the 'essence' of the thing, or of the 'thing in itself'.

Agnosticism thus bears a close relation to the doctrine of Kant, with its unbridgeable gulf between the appearance and the 'thing-in-itself', between idea and reality, between mind and nature. Agnosticism is also closely connected with the scepticism of Hume, who rejected the idea of the existence of a 'thing-in-itself', and acknowledged only the existence of sensations.

Agnosticism can include the question of the existence of God and the supernatural, a similar attitude of 'no knowledge' being maintained. It is therefore a poor evasion of the issue between natural and 'supernatural', between science and religion.

The difference between materialism and agnosticism is described by Lenin as follows: "Those who follow the line of Kant and Hume . . . call us materialists "metaphysicians", because we recognize the objective reality which is given us in experience, because we recognize an objective and independent source of our sensations. We materialists, after Engels, term the Kantians and Humeans agnostics, because they deny the objective reality of the source of our sensations. Agnostic is a Greek word: *a* "no", *gnosis* "knowledge". The agnostic says I do not know whether there is an objective reality which reflects and is reflected by our sensations; I declare it impossible to know. . . . Hence the denial of objective truth by the agnostic, and the tolerance—a bourgeois, philistine, cowardly tolerance—of the dogmas of house goblins and wood demons, Catholic saints and the like' [7].

The weakness of agnosticism is very clearly shown by Engels in the following description from *Historical Materialism*:—

‘What, indeed, is agnosticism, but, to use an expressive Lancashire term, “shamefaced” materialism? The agnostic’s conception of nature is materialistic throughout. The entire natural world is governed by law, and absolutely excludes the intervention of action from without. But, he adds, we have no means either of ascertaining or disproving the existence of some Supreme Being beyond the known universe.

‘Again an agnostic admits that all our knowledge is based upon the information imparted to us by our senses. But, he adds, how do I know that our senses give us correct representations of the objects we perceive through them?

‘Now this line of reasoning seems undoubtedly hard to beat by mere argumentation. But *before there was argumentation there was action. Im Anfang war die Tat.* And human action had solved the difficulty long before human ingenuity invented it. *The proof of the pudding is in the eating. From the moment we turn to our own use these objects, according to the qualities we perceive in them, we put it to an infallible test the correctness or otherwise of our sense-perceptions.* If these perceptions have been wrong, then our estimate of the use to which an object can be turned must also be wrong and our attempt must fail. But if we succeed in accomplishing our aim, if we find that the object does agree with our idea of it, and does answer the purpose we intended it for, then that is positive proof that our perceptions of it and of its qualities, *so far*, agree with reality outside ourselves. And whenever we find ourselves face to face with a failure, then we are generally not long in making out the cause that made us fail; *we find that the perception upon which we acted was either incomplete and superficial, or combined with the results of other perceptions in a way not warranted by them—what we call defective reasoning.* So long as we take care to train and to use our senses properly, and to keep our action within the limits prescribed by perceptions properly made and properly used, so long we shall find that *the result of our action proves the conformity of our perceptions with the objective nature of the things perceived.* Not in one single instance, so far, have we been led to the conclusion that our sense-perceptions, scientifically controlled, induce in our minds ideas respecting the outer world that are, by their very nature, at variance with reality, or that there is an inherent incompatibility between the outer world and our sense-perceptions of it’ [8].

Engels here sets up the *criterion of practice* in ascertaining the truth of our perceptions. Our mental representations of objective reality are found to coincide with that reality in so far as our actions are in accord with our conceptions. The carrying out of our ideas in practice proves their correspondence to physical reality. This test of truth is rejected by many 'philosophers' as being 'vulgar' and 'illegitimate'. These armchair critics are of the opinion that philosophical truths are not to be associated with the action of life, but are purely intellectual will-o'-the-wisps to be pursued academically by 'high-minded' scholars. Consequently they deny that practice proves the correspondence (approximate) of our ideas of things to independent physical reality.

In contrast to this idealist viewpoint, there is the materialist one formulated by Engels, and emphasized by Lenin as follows: 'From the standpoint of life, practice ought to be the first and fundamental criterion of the theory of knowledge. It inevitably leads to materialism, brushing aside the infinite inventions of professorial scholasticism. Of course we must not forget that the criterion of practice, in the nature of things, neither confirms nor refutes *completely* any human presentation. This criterion is sufficiently indefinite not to allow human knowledge to become "absolute", and at the same time sufficiently definite to wage a bitter struggle with all varieties of idealism and agnosticism' [9].

The criterion of practice is also referred to by Engels in an attack on the neo-Kantian agnostics, who say: 'We may correctly perceive the qualities of a thing, but we cannot by any sensible or mental process grasp the thing in itself. This thing-in-itself is beyond our ken' [10].

Engels replies to these agnostics: 'To this Hegel, long since, has replied: If you know all the qualities of a thing you know the thing itself, nothing remains but the fact that the said thing exists without us; and when your senses have taught you that fact, you have grasped the last remnant of the thing-in-itself, Kant's celebrated unknowable *Ding an sich*' [11].

With reference to things previously regarded as unknowable, Engel adds: 'One after another these ungraspable things have been grasped, analysed, and, what is more, *reproduced* by the giant progress of science; and *what we can produce we certainly cannot consider as unknowable*' [12].

Engels' example of a 'thing-in-itself' whose true nature was once supposed to be unknowable, but which has since been

actually built up by chemists from its components, is the colouring matter *alizarine*. He says: 'The chemical substances which go to form the bodies of plants and animals remained just such a thing-in-itself until organic chemistry undertook to show them one after the other, whereupon the thing-in-itself became a thing for us, as the colouring matter in the roots of madder, alizarine, which we no longer allow to grow in the roots of the madder in the field, but make much more cheaply and simply from coal tar' [13].

Like the belief in the existence of an independent objective reality, the criterion of practice is instinctively maintained by scientists. For example, Professor Arthur Thomson, who is certainly not a conscious materialist, nevertheless uses materialistic arguments, such as when he says of scientific description: '*There is no doubt that it often attains to a close fit with reality. This is proved by the basis it affords for prediction, for prediction that comes true*' [14]. Here, in an epistemological question, scientific ideas, or descriptions, are held to represent reality ('a close fit') because ideas (predictions) based on them are fulfilled in practice.

Certain 'philosophers' separate the human value of scientific predictions from the epistemological validity of the criterion of practice. This is a totally unjustified separation, for the criterion of practice is naturally just as sound in the theory of knowledge as it is in scientific theory. Anyone may assert that his ideas about independent reality are roughly correct because in practice they 'work', i.e. they afford a basis for dealing with that reality. He is then using the criterion of practice in an epistemological sense. A scientist may assert that the atomic theory is approximately correct because in practice it 'works', i.e. it affords a basis for predicting and controlling certain changes. He is then using the criterion of practice in science.

The materialist considers the criterion of practice to be applicable with justification in both cases. Many idealists, however, following Mach, refuse to admit the use of the criterion of practice in the theory of knowledge, and only allow its application in scientific theory. This separation of the criterion of practice from epistemology is a convenient way for idealists and agnostics to avoid difficulties in argument, but the separation is a purely arbitrary one, having no other basis than the sophistry of these 'philosophers'.

Planck is another scientist who indicates the necessity for

the criterion of practice. He emphasizes (in somewhat biblical language): 'a lasting confidence in the force of the Word which, for more than 1,900 years, has given us an infallible test for distinguishing false prophets from true—"By their fruits ye shall know them!"' Whatever the exact scope of this application of the criterion of practice, it coincides in the main with the principle of the saying (used by Engels): 'The proof of the pudding is in the eating!'

3 THE APPLICATION OF MATERIALISM

There are some 'practical' persons who doubt the value or truth of any philosophy. They are often strong supporters of science, and also of determinism—which deals with necessity in nature, cause and effect, natural law, etc. Let us face the issue of the meaning and value of philosophy. In the first place, the controversies of philosophy concern chiefly the relation between mind and matter. For some two thousand years philosophers have debated the nature and relation of mind and of matter—or body, and of 'soul'—of flesh and 'spirit'. The conflict has embraced religion, science, ethics, and politics. In modern times it has acquired special significance on account of scientific discoveries concerning the origin and development of the earth, of life, and of mind. The works of Darwin, Haeckel, Huxley and other writers of last century drew the furious anger of hundred of idealists, theologians, cleries and mystics who resented having their temples of philosophy and religion 'desecrated' by the unwelcome truths of science. In the present century science has dealt further shattering blows to theological doctrines, but instead of a mass attack from the orthodox Church and openly anti-scientific idealists, we find idealism and religion being defended chiefly by a small number of eminent scientists on the one hand, and 'adapted' by a few 'unorthodox' cleries on the other. The defence of religion takes the form of subjective idealism, and of mysticism, often with a mixture of pseudo-science. The absurdities propounded are often wrapped round with abstruse doctrines and obscure terminology, giving a 'learned' disguise.

The defence of idealism and religion by various scientists is certainly not entirely new, but the form of the conflict between science and religion has changed. The Church has been forced

into silence by the facts of science, but the attempts to undermine the foundations of science are going on *within scientific circles*. The more highly placed the scientist, the more apt is he (with notable exceptions) to embrace idealism, theology, mysticism, and the supernatural. This applies particularly to England, and there are, of course, sociological reasons for it. Certain journalists play the part of bell-ringers to those scientists who have assumed metaphysical 'authority'. We shall analyse the arguments of some of these writers, but before doing so it is necessary to see what is the position of philosophy in society.

Some people regard philosophy only as a putting of one's thoughts in order. Others regard it as more or less idle speculations about anything under the sun. Both these views leave unexplained the long drawn out controversies between the various schools of philosophy, and above all between the materialists and idealists, causing quarrels, breaks of friendship, and social ostracism. If philosophy is only a question of putting one's thoughts in order, or if philosophy is simply random speculation, then why have such definite, enduring and bitter controversies broken out?

The answer to this involves the relations between philosophy, religion, and science. Religion is a factor of the relation, and religion is the concern of the Church—and the Church is the ally of the State—and the State is the instrument of the ruling class in society. . . . Some implications of philosophical controversies now begin to appear!

The value of idealism to religion, and the danger to it of materialism, was frankly stated by Bishop Berkeley as follows :

'How great a friend *material substance* has been to atheists in all ages were needless to relate. All their monstrous systems have so visible and necessary a dependence on it that, when this corner-stone is once removed, the whole fabric cannot choose but fall to the ground, inasmuch that it is no longer worth while to bestow a particular consideration on the absurdities of every wretched sect of Atheists' [15].

'Matter being once expelled out of nature drags with it so many sceptical and impious notions, such an incredible number of disputes and puzzling questions which have been thorns in the sides of divines as well as philosophers, and made much fruitless work for mankind, that if the arguments we have produced against it are not found equal to demonstration (as to me

they evidently seem) yet I am sure all friends to knowledge, peace, and religion have reason to wish they were' [16].

Modern subjective idealists who attempt to remove matter from the world are not all as frank as Bishop Berkeley, but their philosophical labours are directed towards the same ends, however this fact may be disguised.

This then may be said for materialism, that, upheld by science, it defends our knowledge of nature against idealists and mystics, who would conjure away the world of objective reality, and replace it with fantastic subjective creations of their own minds.

Materialism, in entering into all sciences, stimulates and steadies scientific effort; this is recognized by Max Planck, the well-known German scientist, in his *Survey of Physics*, as follows: 'Belief in some sort of reality outside us . . . alone provides the necessary point of support in our aimless groping; and only it can uplift the spirit wearied by failure and urge it onwards to fresh efforts. . . . This undoubting belief points the way to the progressive creative power . . . *belief alone is not enough . . . to remain a trustworthy guide it must be continually verified by logic and experience*, and to this end the only ultimate aid is conscientious, and often wearisome and self-denying effort' [17]. Planck thus points out the practical value of materialist philosophy, and also indicates the necessity for the criterion of practice ('experience') in our theory of knowledge.

Here a question of supreme importance arises, namely, is philosophy merely to 'explain' the world? The above quotation from Planck indicates that the role of materialism is more than this. *Science* does not only explain the physical world, but also is constantly changing it. Science has helped to move mountains, drain lakes, connect oceans, plant forests, as well as to create the material structures of advanced society—cities, ports, railways, etc. *Materialism* is the general outlook of science, and in so far as it helps towards an understanding of nature, it is working with science in the changing of nature.

Along with the material changes which science has brought about in nature, there are the social changes. The organization and characteristics of society are very different from what they were several hundred years ago. The collection of workers in factories and cities, the rapid movements of comparatively large sections of the population, the greater centralization, the greater centralization of authority—in the State and in the financial trusts, all these features of society are of recent appearance,

brought about largely through the advent of science under the influence of historical conditions.

In addition to social changes there have been changes in the individual. For example, a British factory worker today must have a different mentality—a different outlook on life—from that of a serf in feudal times, who was tied to the land he worked on, did not draw wages, and knew little or nothing of the outside world.

All this bears out what Marx wrote in the first volume of *Capital*: 'By acting on nature outside himself, man changes his own nature'.

The philosophy of materialism—the theory of knowledge based on science—is the elaboration of the instinctive recognition of objective reality by scientists, and indeed by humanity in general. Its function is to change the world, in connection with the giant progress of science.

Included under science, there are the social sciences, e.g. of economics and politics, and it is to these that Marx drew special attention, in showing that whereas previously philosophers had attempted to explain the world, the task of philosophy is now to change it. This view is well put by D. B. Ryazanov, in his *Marx and Engels*, where Marx's recasting of the work of the German philosopher Feuerbach is thus described:—

'Like the French materialists, Feuerbach taught that man was the product of circumstances and education, the product of existence acting upon consciousness. Thus man as he is with his head, hands, feet, etc., and set apart from the animal kingdom, was viewed as a sort of sensitive apparatus subjected to the influences and the action of nature upon him. All his thoughts, his ideas, are reflections of nature upon him. According to Feuerbach it seemed, therefore, that man was a purely passive element, an obedient recipient of impulses supplied by nature.

'To this proposition Marx opposed another. Everything, he insisted, that goes on within man, the changes of the man himself, are the effects not only of the influence of nature upon man, but even more so of the reaction of man upon nature. It is this that constitutes the evolution of man' (p. 58).

'Thus Marx introduced a revolutionary, active element into Feuerbach's passive philosophy. *The business of philosophy*, maintained Marx, in contradistinction to Feuerbach, *is not only to explain this world, but also to change it.* Theory should be

supplemented by practice. The critique of facts, of the world about us, the negation of them, should be supplemented by positive work and by practical activity. *Thus had Marx converted Feuerbach's contemplative philosophy into an active one. By our whole activity must we prove the correctness of our thought and our programme* [18].

'How can this world be changed? inquired Marx, and answered that the class whose historical mission it is to change the social order and to bring freedom is the working class, the proletariat.

It may be asked: Is there such a thing as freedom? Certainly the doctrine of freewill is false, as science has shown conclusively, but materialism does not deny that man can, in some measure, be free. 'Freedom is the recognition of necessity'. This may appear paradoxical, but it is none the less true. We say that it is knowledge of necessity in nature—of causal laws—which gives us freedom to use natural forces, governed by natural laws, for our own conscious ends. Engels writes on freedom and necessity as follows:—

'Hegel was the first man to give a proper explanation of the relation of freedom and necessity. In his eyes freedom is the recognition of necessity. "Necessity is blind only in so far as it is not understood". Freedom does not consist in any imaginary independence of natural laws but in a knowledge of those laws and in the possibility thence derived of applying them intelligently to given ends. . . . *Freedom, therefore, consists in a mastery over ourselves and external nature founded upon the knowledge of the necessities of nature*' [19].

Max Planck takes a similar view of freedom and necessity. He says: '*Self-determination is given to us by our own consciousness*, and is not limited by any causal law, and he who considers it logically irreconcilable with absolute determinism in all spheres of philosophy, makes a great mistake. . . . Science thus fixes for itself its own inviolable boundaries [of determinism]. But man, with his unlimited impulses, cannot be satisfied with his limitation. He must overstep it, since he needs an answer to the most important and constantly repeated question of his life: What am I to do?—and a complete answer to this question is not furnished by determinism, not by causality, especially not by pure science, but only by his moral sense, by his character, by his outlook on the world' [20]. It is this outlook on the world which constitutes philosophy, and consequently it is the part of materialism to guide men's actions in the changing of the world.

4 SCIENCE AND RELIGION

The conflict between science and religion is well known. In the writings of those idealists whom we shall criticize there are strenuous attempts to reconcile the two. Also, it becomes apparent that *idealism is the philosophical basis of religion*.

Science consists of systematized knowledge about the physical world; it is authoritatively defined as 'ordered knowledge of natural phenomena and of the relations between them' (*Encyclopædia Britannica*, 14th ed., vol. 20, p. 115). The observation of nature gives the facts of science, and it is on facts that a scientific theory is built. A theory is an explanation of certain aspects of nature, and as the famous naturalist Ernst Haeckel (1899) remarked, 'must always be regarded only as an approximation of the truth' [21]. Haeckel here presented the view of dialectic materialism instinctively, so to speak, as do the majority of scientists.

The explanations of science are based on the observation of nature, on the collection and classification of facts. Facts of observation constitute the empirical basis of scientific reasoning which results in hypotheses and theories being formed. The truth of scientific hypotheses and theories is tested by experiment—by further observation of natural phenomena. Science is thus *rational* in so far as observation and experiment are combined with reason to form theory.

The process of scientific advance is described in the *Encyclopædia Britannica* (14th ed., vol. 20, p. 121) as follows: 'The multitude of phenomena are too great for any subject which aims at explanation and not only at description to be attacked with success without the aid of hypothesis framed by the use of the scientific imagination. Facts are collected to prove or disprove the consequences deduced from the hypothesis, and thus the number of facts to be examined becomes manageable. If agreement is found, the hypothesis is, so far, confirmed, and gains in authority with every fresh concordance discovered. If the deductions from the hypothesis do not agree with the accepted interpretation of facts, the hypothesis may need modification, it may have to be abandoned altogether, or the want of concordance may point to some error or inconsistency in the fundamental concepts on which the hypothesis is based—the whole framework of that branch of science may need revision'.

In contrast to science, religion depends on 'faith' and 'revela-

tion', instead of facts and reason. It is based on subjective feelings of emotion, and refuses to resort to observation and experiment when its assumptions are challenged.

The various doctrines of religion constitute theology. The theology of the medieval scholastics was only 'rational' in so far as it consisted of abstract logic based on certain premisses. The absurdity of these premisses came from faith in religious doctrines. For example, fierce arguments and keen logic centred round the question of how many angels could stand on the point of a needle! The attitude of science would have been to demand an experimental proof of the existence of angels, and a demonstration of them tightly packed for counting on the point of the needle! Theology, however, relies on 'faith' and 'revelation' in asserting the existence of God and the angels.

The origin and nature of religion has long been disputed but scientific investigations of past historical periods have shown conclusively that *religion is a social product*, necessarily created in the course of the evolution of society. The German writer Ludwig Feuerbach was one of the first to embody this truth in philosophical literature. This is commented upon by D. B. Ryazanov as follows: 'In his criticism of Christianity, Feuerbach came to the same conclusions to which the eighteenth century materialists had come. But where they had seen only deceit and bigotry, he, who had gone through the Hegelian school, discerned *a necessary phase of human culture*. But even to Feuerbach man was as much of an abstract figure as he was to the materialists of the eighteenth century' [22].

Ryazanov then points out that Marx completed Feuerbach's effort to reveal the nature of religion by demonstrating the nature of man, who in general is not only part of nature, but struggles against nature as a *social being*. Religion is created in the course of the struggle of society against nature, and is therefore a *social product*. The religious sentiment is therefore not something 'natural', like the flow of water downhill, but is produced in the course of social changes. Having been produced through social efforts and changes, there is no reason why it should not disappear through social efforts and changes.

This is the view of Freud in his volume on religion entitled *The Future of an Illusion*. 'I have tried to show', writes Freud, 'that religious ideas have sprung from the same need as all the other achievements of culture: from the necessity for defending itself against the crushing supremacy of nature' [28]. This is

what Freud has to say about the religion of old-time Russia:—

‘Russian mysticism has come to the sublime conclusion that sin is indispensable for the full enjoyment of all the blessings of divine grace, and therefore, fundamentally, it is pleasing to God. *It is well known that the priests could only keep the masses submissive to religion by making these concessions to human instincts!*’ [24].

In Western Europe, Christianity is now failing to keep the masses of the people piously subdued. As a result, ‘philosophers’ and others are attempting to replace the outworn creeds with mysticism. For example, C. E. M. Joad, in an address to the National Union of Students at Cambridge (April 2, 1930) is reported to have said: ‘Clergymen fiddle while the Church burns. Churchmen are absorbed in controversies over technical matters of no interest to the layman. . . . It seems probable, if present tendencies continue, that science will deliver the *coup de grace* to organized Christianity in a hundred years. . . . Today young men and women are so educated as to find it impossible to accept the old view of religion. Whenever they enter a church they are required to leave their intelligencies in the porch. . . .

‘A generation is growing to maturity which is to all intents and purposes without religion. They do not believe, they do not want to believe, and the subject bores them.

‘The present generation has shown religion to be a fiction; it has still to come to terms with the needs which created the fiction. It has knocked the bottom out of the universe of the Victorians, and dropped their Gods through the hole; it has now to fill the vacuum it has made. . . .

‘It seems unlikely that the present decline in organized religion will be arrested. Christianity in its traditional form will not recover its influence. . . .

‘*Mysticism must become the common heritage of the race instead of the unique privilege of its most favoured children*’ [25].

This was a significant admission of the decline of the influence of the Church, and an interesting sidelight on the role of the ‘favoured children’ of mysticism, to whom Mr. Joad presumably belongs.

Freud’s exposure of the old Russian mysticism is followed by this statement on the retreat of religion before the march of science: ‘The scientific spirit engenders a particular attitude to the problems of this world; before the problems of religion it halts for a while, then wavers, and finally here too steps over

the threshold. In this process there is no stopping. The more the fruits of knowledge become accessible to men, the more widespread is the decline of religious belief, at first only of the obsolete and objectionable expressions of the same, then of its fundamental assumptions also. The Americans who instituted the monkey trial at Dayton have alone proved consistent. Elsewhere the inevitable transition is accomplished by way of half-measures and insincerities' [26].

Addressing himself to supporters of religion, Freud says '*I disagree with you when you go on to argue that man cannot in general do without the consolation of the religious illusion*, that without it he would not endure the troubles of life, the cruelty of reality. Certainly this is true of the man into whom you have instilled the sweet—or bitter-sweet—poison from childhood on. But what of the other, who has been brought up soberly? Perhaps he, not suffering from neurosis, will need no intoxicant to deaden it. True, man will then find himself in a difficult situation. He will have to confess his utter helplessness and his insignificant part in the working of the universe; he will have to confess that he is no longer the centre of creation, no longer the object of the tender care of a benevolent providence. He will be in the same position as the child who has left the home where he was so warm and comfortable. But, after all, is it not the destiny of childishness to be overcome? Man cannot remain a child for ever; he must venture at last into the hostile world. This may be called '*education in reality*' [original italics]; need I tell you it is the sole aim of my book to draw attention to the necessity for this advance?' [27].

Finally, Freud points to the freedom and advantages to be gained from the overthrow of religion: 'Man, by withdrawing his expectations from the other world and concentrating his liberated energies on this earthly life . . . will probably attain to a state of things in which life will be tolerable for all and no one will be oppressed by culture any more' [28].

Freud's 'culture' is, of course, bourgeois civilization—which is based on the capitalist system of society. Freud's account of religion is in agreement with the teaching of Marx that the foundation of the criticism of religion is: 'Man makes religion, religion does not make man'. 'Religion', wrote Marx, 'is the moan of the oppressed creature, the sentiment of a heartless world, and it is the spirit of spiritless conditions. *It is the opium of the people*' [29].

Chapter II

MODERN MATERIALISM

1. THE RELATION OF MATERIALISM TO SCIENCE

PHILOSOPHY has been defined as follows: 'In the broadest scope, any attempt to present or conceive a systematic view of all things is a philosophy . . . an attempt to present all or many sciences in their mutual relations is usually a system of philosophy'. (Webster's International Dictionary.) The struggle between idealists and materialists is the outstanding feature of philosophical controversies and is closely connected with the conflict between science and religion.

Modern materialism gains many of its arguments from the discoveries of science, while religion finds support in the sophistries of idealists. From this arises the bitterness and heat of philosophical controversies. Certainly, there are scientists who propound idealism, and also there are those who profess religion yet argue as materialists. This, however, does not affect the truth of our remarks, and neither does the comparative lack of materialist opinion in modern British literature.

It is interesting to notice that while materialism in England is now perhaps less evident than in other European countries, it gained its early impetus from the support of English writers! Francis Bacon, though his writings included theological inconsistencies, was one of the earliest European materialists. 'The real progenitor of English materialism is Bacon', [1] said Marx. After Bacon, it is Hobbes 'who systematizes Baconian materialism' [2]. Hobbes wrote: 'The imagery and representation of the qualities of the things without, is that which we call our conception, ideas, notice, or knowledge of them' [3]. Following on Hobbes, Locke, in his *Essay Concerning Human Understanding*, furnished a proof of Bacon's fundamental principle, namely, the origin of all human knowledge from the world of sensation.

As Engels points out, Bacon, Hobbes and Locke are the fathers of the brilliant school of French materialists of the eighteenth century.

These French materialists, of whom Diderot was the greatest, were among those writers called the 'Encyclopedists', because

they contributed to the famous *Encyclopedia* of the time. The 'Encyclopedists' were the forerunners of the French revolution. Some of them were persecuted for their materialist and atheist opinions, and they played a considerable part in the overthrow of French feudal authority, the forces of which were stifling new thought. Among the eighteenth century materialists were Holbach, Helvetius, Cabanis and Lamettrie.

Modern dialectic materialism differs from the crude, rigid materialism of the eighteenth century, which gave mechanical explanations of life, tending to neglect chemical and other processes of organic nature. This early French materialism also lacked the *dialectic* element added later by Feuerbach, Marx and Engels.

The *relative* truth of human knowledge was not realized in connection with the *absolute* truth that the physical world exists independently of human perceptions. The French materialists also did not grasp properly the *historical* aspect of materialism.

This crude, anti-dialectic materialism appeared later in Germany in the nineteenth century, in the writings of Büchner, Vogt, and Moleschott, who derived their views partly from the eighteenth century French materialists. Engels criticized these writers for the obvious faults and limitations of their materialism, and for despising the dialectic of Hegel because they did not understand its use. Engels termed this materialism 'metaphysical' in so far as it was anti-dialectic, making absolute distinctions, and pretensions to absolute knowledge.

Dietzgen (1828-1888), who wrote from the angle of materialism, presented it in the following dialectic form: 'The human organ of cognition radiates *no metaphysical light, but is a piece of Nature which pictures other pieces of Nature*. . . . Our faculty of recognition is not a supernatural source of (absolute) truth, but a mirror-like instrument which reflects the things of the world, or Nature' [4] (with relative truth).

In the following chapters we continually emphasize the distinction between matter and mind in connection with the primacy of matter, but Dietzgen's words draw attention to the relativity of this distinction outside the limits of our discussion. We may quote the following remark of Lenin on this point: 'Of course the contradistinction between matter and mind has an absolute significance only between the boundaries of a very limited region—in this case exclusively within the limits of the fundamental epistemological problem of what was to be con-

sidered primary and what secondary. Beyond these bounds the relativity of the contradistinction is unquestionable' [5].

Dietzgen's materialism may be contrasted with the crude materialism of Vogt, who assumed that thought was secreted by the brain as bile is secreted by the liver! It is true that Vogt did not pretend to know exactly how the brain produced thought, but his opinion on thought was confused.

Dialectic materialists do not pretend to know the exact means *whereby the human mind reflects external reality*, but we do know that this process is a function of the human brain. There is a vast field of scientific research in connection with the brain function, and work of the highest importance has already been done by Professor Pavlov of Leningrad. This work is dealt with in another chapter, but its importance calls for immediate mention. Pavlov's attitude to his subject is that summarized by Feuerbach in the statement: 'I am a psychological object for myself, but a physiological object for another person' [6]. Pavlov's work includes an analysis of the behaviour of animals into reflexes. A certain type of reflex, the *conditioned reflex*, is found to depend in particular on the cerebral cortex for its creation. Conditioned reflexes are acquired and unstable, in contrast to unconditioned reflexes, which are inborn and stable. The behaviour of an animal usually referred to as psychological behaviour can now be traced to the elaboration of conditioned reflexes. In this way psychology is more firmly linked to physiology, and an important step is taken towards investigating the creation of states of mind through the functioning of the brain. We can now see with the help of Pavlov's work not only the connection between a certain environmental circumstance and a particular state of mind, but also an outline of at least part of the neurological process concerned. Furthermore, the possibility is suggested of a comprehensive objective analysis of the behaviour of human beings, whose psychological behaviour is so infinitely more predominant and complex than that of the lower animals. Pavlov's work indicates a unit of animal behaviour, not excluding that of man in his highest activities. How far science can use this unit of the conditioned reflex in an analysis of individual human behaviour remains to be seen. In any case, Pavlov has demonstrated a fact of the greatest importance, namely that the cerebral cortex, the highest development of the nervous system, includes in its function the creation of *special* (conditioned) reflexes.

The *Lancet*, in a review of Pavlov's *Lectures on Conditioned Reflexes*, stated: 'It can scarcely be questioned that the association of Pavlov with conditioned reflexes will remain as historical a combination as that of Darwin and evolution'.

Pavlov has devoted his attention to the behaviour of animals through the *functioning* of the nervous system. Other scientists have studied the *development* of the nervous system, as a part of *embryology*, the science of the development of organisms.

The discoveries of science are the steps up which materialism climbs to gain a wider and clearer view of human knowledge. The basis of materialism is the acknowledgment of the existence of the physical world, independent of thought. Dialectic materialism holds that we can gain approximately correct mental images of that physical world by means of our senses.

Scientists deal with the phenomena of the physical world, and therefore naturally adopt the materialist point of view. Professor J. Johnstone, of the University of Liverpool, recognizes this as follows: 'A modern, scientific, realistic philosopher would say that there were certainly sensible objects which stimulated our organs of sense, and there were also "representations", or mental images, of those sensible objects in our consciousness, the sensible, external things which originate physical stimuli being "objective" to us, while the images, or mental representations, were subjective' [7].

Here is complete support for modern materialism, which is abundantly confirmed in its opinions by the discoveries of science.

The sciences of astronomy and geology show that the physical world existed long before living things developed. Living matter must have at some time originated from non-living matter, under conditions which may or may not be reproduced in the future. Although the means whereby living things came into existence is still only a matter of conjecture, the evolution of living things has been revealed to a great extent by Darwin and others. Man is known to have evolved from forms of life so simple as to possess no differentiated nervous elements. As more highly developed forms of life appeared on earth, differentiated nervous elements came into being, resulting eventually in the elaborate nervous system of mammals. From observations of the behaviour of existing animals, we infer the growth of mind and intelligence along with the development of the nervous system.

It is believed by some scientists that mind in a latent and undeveloped form may exist in undifferentiated protoplasm (the general physical basis of life). C. U. A. Kappers, in his *Evolution of the Nervous System* (1929), says: 'It is very likely that even such functions as memory, attention and association, generally considered as features of mental life only, and, as such, looked upon by most people as being exclusively functions of the brain, are *inherent in living protoplasm in general* . . . nervous activities such as reception, conduction and correlation of stimuli, are special developments of general properties of organic tissue in which even processes functionally analogous to memory, attention and association are inherent' [8].

In simpler language, thinking, or mind, is a property of matter, inherent in comparatively undeveloped living matter (protoplasm). It becomes possible, therefore, to assume the existence of a property similar to sensation 'in the foundation-stones of matter itself'. This supposition was made in the past by Ernst Haeckel (1899), and even by a materialist of the 18th century (Diderot's conjecture).

Although the potentiality of mind must have existed in simple forms of life (e.g. in the amoeba, a unicellular speck of protoplasm), yet mind *in a well expressed form*, that is, sensation, consciousness, reason, is connected only with the higher forms of life—with more highly developed and differentiated organic matter. As we examine the ascending scale of forms of life, we find as a characteristic feature the development of a nervous system (consisting of nerve cells, collections of cells . . . nerves . . . spinal cord . . . brain). In mammals, and especially in man, a tremendous growth of the 'neopallium', or 'neocortex', of the brains occurs, new cells and layers of cells forming.

The interrelations of different parts of the brain have been the subject of much study, e.g. by Sir Arthur Sherrington and Professor Elliot Smith, and many interesting facts have been observed by these and other workers in connection with this development of the nervous system. Recently, results have been published dealing with the function of the brain and nervous system as a whole. These investigations have been carried out by the objective method, i.e. by observing the behaviour of animals. Pavlov's work has already been mentioned. His conclusions are that the highest nervous activities of animals, including man, are functions of the cortex of the brain.

Other work on mind and animal activity is described by Köhler in his *Mentality of Apes* (1926).

All these advances in science afford confirmation of the truth of materialism, that *mind is a function of organized matter*. Materialism places matter in a position prior to mind just because science has shown that mind (i.e. thought, reason, consciousness) is a derivative of organic matter, which has developed into higher forms of life in the course of natural evolution. The *dependence* of the consciousness of a person on the brain is shown by the disturbances of consciousness accompanying injuries and modifications of the brain substance. Following on the work of Pavlov, man will no doubt discover more and more about the actual means whereby the brain causes the energy of external stimuli to produce mental images and thought.

It is necessary to emphasize that it is the generally known discoveries of science which strengthen the position of materialism. The truth of the evolution of the earth and of living things is a confirmation of materialism. On the other hand, the different theories of the formation of the planets, or the different theories of evolution (e.g. Darwinism and Lamarckism) are not identical with materialism. They must not be confused with epistemology, the theory of knowledge. Similarly, in physics, the teaching of this or that construction of matter must not be confounded with the truth of the existence of matter, of the physical world, apart from human perception and thought.

Materialism rests on the basis of science, but the movements, even the upheavals of that basis do not shake it, for modern materialism is not a rigid, lifeless doctrine. On the contrary, it is a flexible, living knowledge, which recognizes certain absolute truths (e.g. the independent existence of the physical world), and also relative truths (e.g. the theory of evolution, and the atomic theory). In so far as it admits the existence of an external world, it serves as an encouragement to explore that world. In so far as it recognizes that our knowledge of the external world is only approximate, it preserves our balance when previous ideas about nature are upset, and have to be discarded or altered.

2. THE DEVELOPMENT OF THE NERVOUS SYSTEM

An extremely interesting aspect of the development of the nervous system is what is known as *neurobiotaxis* [9]. The unit

of the more highly developed nervous system is the *neurone*, a nerve-cell characterized by two kinds of offshoots (axon and dendrites). From neurones and their offshoots the nerves and nervous system of an animal are built up. From observation and experiment on the development of nerve-cells, it has been found that the growth of neurone offshoots and of nerves is directed by stimulation from other parts of the animal structure. That is, *physiological stimulation* from various points of the developing animal body determines the direction of the growth of the nerves, and is consequently a determining factor in the formation of the nervous system as a whole. 'A concentration of nervous tissue takes place in the region of greatest stimulation' [10].

The growth of the offshoots of nerve-cells growing experimentally, outside the animal body, has been directed by means of electrical stimulation [11], and it is thought that the growth of nerve-cell offshoots within the body, under natural conditions, may be influenced by a similar factor. Jordan and Kindred, in their *Embryology* (1926) state: 'The fundamental explanation of neuroblast [embryo nerve-cell] differentiation and shifting under the influence of an adjacent irradiating fascicle [nerve-bundle] may be conceived in physico-chemical terms. The process may ultimately be one analogous to an electromagnetic response' [12].

The significance of a natural explanation of the formation of neurone offshoots and of groups of neurones lies in the fact that *it is the neurones (nerve-cells) of an individual which form the material basis of his mind. Without neurones there can be no mind*, and in the case of idiots there is a deficiency of developing neurones (neuroblasts) in the the brain. The *non-nervous* cells (spongioblasts) may be present in normal, or even excessive amount, in a person of feeble intelligence. The difference between the amount of nervous and non-nervous cells in a person's brain is a determining factor in his intelligence. Referring to this difference, Professor Berry, in his *Brain and Mind*, says: 'Between the human microcephalic idiot and the multi-neuronic big-headed type of genius the differences are so pronounced as to be obvious to the most unobservant. The *post-mortem* differences reveal themselves in the size and weight of the brain. The differences in the mental reactions are equally striking and prove the formula—no neurone, no mind' [13].

Berry also indicates how brilliantly the teaching of materialism is being verified as follows: 'The real difficulty in correlating psychology with neurology lies in the fact that as we pass from

the simple reflex neuronics to the highly complex, which involve mind and intelligence, we become less and less familiar with the extraordinary complexity of the paths followed by the neuronics involved. *There is, however, no doubt at all that the same type of neuronic machinery which serves for the simpler reflexes is also utilized by nature, though in an immensely more involved form, for the display of the emotions and of mind.* Hence the formula, which cannot be too strongly emphasized, "*no neurone, no mind*". Lastly, even the cerebral complexities of the neuronics are beginning to be understood as this work has endeavoured to show' [14].

Kappers, who has played a leading part in elaborating the theory of neurobiotaxis, compares mental associations (e.g. a certain tune with a certain person who was present when the tune was played previously), with the structural associations found in the nervous system (e.g. between the nerves of taste and smell). He says: 'Exactly as, in the example of a mental association, the remembrance of a special person is associated with a special tune, because it was just that person who in our youth played that tune to us, so in the case of material alterations in the nervous system, only simultaneously associated influences cause the selection . . . one might say: *simultaneous (or immediately successive) stimulations bring about not only mental associations, but also material connections in the nervous system.*

'This is the principle law of neurobiotaxis, which thus is analogous to the principle law of psychology' [15].

The importance of Kapper's work (and that of his colleagues) from the point of view of materialism is that it reveals natural causes (associated nervous stimuli) underlying the formation of the nervous system. It is a remarkable thing that at about the same time as Kappers produced his theory and its successful application, Pavlov formed his well-established theory of conditioned reflexes. In both cases the *association* of different nervous stimuli is shown to underlie nervous and mental activity. In the case of neurobiotaxis, the association of stimuli causes the building up of the nervous system. In the case of Pavlov's theory, the association of stimuli is the basis of the highest nervous activity, and the behaviour of an animal.

In the course of investigations into the development and function of the nervous system, including the brain, discoveries have also been made about the formation of what initiates nervous passages to the brain, namely the sense-organs. It is

found that physico-chemical factors in the environment of an organism determine its development (along with many other factors), including the development of the sense organs. A remarkable experiment illustrating this is on the embryos of a fish (*Fundulus*). In the water normally surrounding the embryos they grow into fish with two eyes on each, one on either side of the head. But 'if a few pinches of simple salt (magnesium chloride) are added to the water in which a fish (*Fundulus*) is developing, that fish will undergo a modified process of development and have not two eyes but one [in the middle of its head], as Stockard showed' [16].

Physico-chemical factors, while entering into the life of an organism, both as part of its being and as part of its environment, are not the only factors involved, for a qualitative change is evident in passing from non-living to living natural phenomena. Biological factors, subject to special laws distinct from those of inorganic matter, characterize the life processes of an organism. In the evolution of a species, biological factors—bio-historical as they have been called—determine development, and these give to the 'biophysiology' of an organism its historical element, which of course is also derived from other factors—mechanical, physico-chemical, etc.

Dialectic materialism emphasizes the *interaction* between organisms and their environment (between the 'internal' and the 'external'), the environment consisting not only of inanimate nature, but also of other organisms. Criticizing a frequent error in this connection, B. Zavadovsky writes: "There are frequent identifications of the "external" in the process of organic evolution with the physical, and of the internal with the "biological"—forgetting that the biological includes physical, chemical and physico-chemical factors as the moment and necessary condition for its realization, while the "external", in regard to a particular organism in its turn is composed not only of the physical conditions of inorganic nature, but also of the biological surroundings of other organisms, in the midst of and in interaction with which the life of the species proceeds. As for man, the "external" consists first of all of socio-economic relations and the condition of material productive forces, by which the socio-historical process is determined' [17].

Embryology has provided an example of a principle of dialectic materialism, in its teaching that *quantitative* changes may result in *qualitative* changes (e.g. the quantitative change in

which water absorbs more and more heat gives rise to a qualitative change—the transformation of water into steam).

Hegel wrote: 'There are transformations of being which are not only changes from one quality to another, but also changes from the quantitative to the qualitative' [18]. Plekhanov, dialectic materialist, wrote: 'Quantitative changes, accumulating by slow degrees, become in the end qualitative changes' [19].

The application of this principle in the development of living organisms is as follows: A developing organism is made up of a material substance, protoplasm, which is constantly undergoing a physiological change (metabolism). As De Beer (Oxford) points out: 'The rate of "metabolism" of the tissues is not the same all over a developing organism. There is a region of high rate of protoplasmic activity, which coincides with the anterior end of the animal, the animal pole of the egg, and the growing point of the plant. From this region the rate decreases progressively towards the posterior end so that there is a gradient. Further, this gradient coincides with the axis of the animal, so that it may be called an axial gradient' [20].

Experiments have shown that if the protoplasmic activity of part of the developing organism is altered—if the physiological (axial) gradient is interfered with, then the formation of the organism proceeds differently. As De Beer says, there is '*experimental evidence that interference with the gradient alters the structure of the organism*' [21]. From this it follows that the differentiation of the various parts of a developing organism is due, in some measure at least, to quantitative differences in the rate of metabolism throughout the organism. '*One must therefore look to quantitative differences in intensity of activity to explain the differentiation of qualitatively different regions of an organism in development*' [22].

De Beer gives a number of experiments illustrating the rôle of axial gradients. These include the action of poisons, ultra-violet light and cutting on developing organisms, such as worms, frogs, and newts. The effects vary and include, for example, variation in the size of the heads of worm larvæ, and asymmetry of the organisms (frog embryo). In the case of pieces cut from the bodies of Planarian worms, 'The frequency of head formation can be controlled experimentally by altering the protoplasmic activity of the piece by poisons' [23].

De Beer points out that 'the existence of an axial gradient explains certain phenomena in normal development, such as

the manner in which certain organs appear before others' [24]. He also says that the cause of the *regulation* apparent in the growth of organisms is to be sought in the rate of protoplasmic activity: 'As to what this process of regulation may be, an explanation must be looked for in the axial gradients of "metabolic" rate. *Qualitative differences of tissues arise from quantitative differences of rate activity*' [25].

A pioneer worker in this field of research is C. M. Child, Professor of Zoology at the University of Chicago. In his book, *The Origin and Development of the Nervous System* (1921), he shows how natural causes may be found for the origin and development of the nervous system, just as natural causes may be found for the functioning of the nervous system. He demonstrates that the regulation and integration of an organism, performed in the adult chiefly by the nervous system, arises in the embryo from 'the simple quantitative gradient.' Child's work is 'an attempt to establish the existence of physiological continuity between the simple quantitative gradient in physiological condition and the nervous system' [26].

The gradients (of the rates of protoplasmic activity of an organism) are concerned with the process of *excitation* of protoplasm and the transmission of that excitation from one region to another. Child writes: 'Viewed as a whole, the condition which we call *excitation*, however brought about, appears to be essentially *an increase in the rate of living, or at least in the fundamental energy-liberating processes concerned in the life of any particular protoplasm*, and transmission consists in the spread of passage of excitation from one region to another, certain dynamic changes in an excited region being the exciting factor for adjoining regions. *The excitation-transmission relation is then an energetic, non-specific or quantitative relation in a protoplasm*, and it may therefore be regarded as the most generalized or most primitive organismic relation' [27].

Later, Child summarizes his view of the development of the nervous system as follows: 'The nervous system . . . represents the primary [protoplasmic] differentiation with respect to the functions of excitation and transmission of the gradients, and as the gradients represent the primary integrating factor in the development of the organism, the nervous system as the differentiated mechanism of this primary integrating function necessarily becomes the chief organ of integration. According to this conception, the nervous system is the physiological and

morphological expression of the excitation-transmission relations, first with respect to the primary or chief physiological gradients, and later with respect to the progressive developmental complications as they arise' [28].

Child's view, which is based on many experiments, amounts to this: the nervous system of a living thing develops as a natural result of the physiological activity of its substance (protoplasm) in its environment. This activity varies throughout an embryo in definite 'gradients'. These gradients at first regulate the activity of the living organism as a whole, and also allow the development of the nervous system to occur.

Child points out that this conception does not take into consideration the factors of heredity: 'The gradients do not determine the nature of nervous structure, but merely provide the physiological basis for the realization of certain of the heredity potentialities of the protoplasm concerned and the problem of the evolutionary origin of these potentialities remains as before' [29].

In his *Biochemistry and Morphogenesis* (1943) Joseph Needham—a critic of Child—says that 'the gradient theory has merged in the general theory of morphogenetic fields' (p. 605). (A morphogenetic field consists of spatially distributed differences of chemical instability within a growing cellular system. These quantitative differences of biological 'potential' determine the system's development of form.) The point is that Child and his critic Needham both present physico-chemical explanations of the development of the nervous system, which includes the brain. The mind is a function of the brain, and as scientists continue to find material causes for the development of the nervous system, they strengthen the materialist view that mind is a derivative of matter, i.e. a product of material developments in the physical world.

It is particularly interesting to note that in connection with the phenomena of both neurobiotaxis and axial gradients there are electrical factors present. The electrical factor in neurobiotaxis has already been mentioned. With regard to axial gradients De Beer writes: 'Protoplasmic activities also involve electrical phenomena, and a gradient of electric potential has been demonstrated along the axis of organisms. The regions of high rate are electro-negative to the others in the external circuit [30].

Child says: 'It may be that in any stimulation of living proto-

plasm the primary change is electrical, but whether that is the case or not it is evident that the electrical change is a factor in the change in physiological state. If we admit this, it follows that electrical polarization of a cell may determine changes in its rate of metabolism and in its physiological state in general' [31].

'Professor E. J. Lund, of Texas University, recently expounded, at a meeting of the Botanical Society of America, an interesting aspect of the theory that *electricity is the force that influences the rate of growth and outward form of all animate matter*. That electricity influences plant-life he claims to have proved by cutting off the supply by the administration of poisons and anaesthetics. This experiment was followed by the application of an outside current, which soon gave rise to a noticeable renewal of activity amongst the plants experimented upon. Professor Lund also affirmed the presence of electricity in trees, the flow being upwards through the outer layers of wood, and earthwards through the inner layers of the bark. The realization of this theory promises to solve many difficult problems connected with the growth of plants. And what applies to plants applies also, with modifications, to all the members of the animal kingdom—not excluding man' [32] (E. G. Boulenger).

More recently, H. S. Burr and F. S. C. Northrop [33], of Yale University, have described experiments demonstrating the existence of an electrical field surrounding an organism. Led to a study of this field by work on the developing nervous system Burr, with the collaboration of Northrop, showed the field around a salamander at the 1939 annual meeting of the National Academy of Sciences of the U.S.A. Electrodes of a vacuum tube micro-voltmeter, placed on or near the surface of an animal's body, show a gradient of electric potential from one end of the body to the other. According to Burr, changes in potential of the animal's electrodynamic field occur with definite physiological events, such as ovulation, and also with the development of pathological states.

The work of Burr and Northrop, and the extensive data of electrocardiography and electroencephalography, point towards the formulation of a *physico*-chemical interpretation of *general* characteristics of living matter. While a living organism is differentiated qualitatively from non-living matter, the qualities which make up its life are nevertheless traceable to specific

physico-chemical conditions and processes. The great generalizations of future biology will undoubtedly be in terms of chemistry and physics, especially field physics.

3. THE ORIGIN OF DIALECTIC MATERIALISM

The origin of dialectic materialism is partly from the crude materialism inherited from the eighteenth century, and partly from Hegel's conception of the *dialectic*, the two types of thought having been purified and blended by Marx and Engels, with the help of Feuerbach.

'There are two possible ways of regarding everything in nature and in society', wrote Bukharin: 'in the eyes of some everything is constantly at rest, immutable'; 'things ever were and ever will be thus'; 'there is nothing new under the sun'. To others, however, it appears that there is nothing unchanging in nature or in society; 'all earthly things have passed away'; 'there is no going back to the past'. This second point of view is called the *dynamic* point of view (Greek *dynamis*, 'force', 'motion'); the former point of view is called *static*. Which is the correct position? Is the world an immovable and permanent thing, or is it constantly changing, constantly in motion, different to-day from yesterday? Even a hasty glance at nature will at once convince us that there is nothing immutable about it. People formerly considered the moon and the stars to be motionless, like golden nails driven into the sky; likewise, the earth was motionless, etc. But we now know that the stars, the moon, and the earth are dashing through space, covering enormous distances. And we also know that the smallest particles of matter, the atoms, consist of still smaller particles, electrons, flying about and revolving within the atom, as the heavenly bodies of the solar system revolve around the sun. But the whole world consists of such particles; and how can anything be considered constant in a universe whose component parts gyrate with whirlwind speed? It was formerly also believed that plants and animals were as God created them: ass and asafœtida, bedbug and leprosy bacillus, plant-house and elephant, cuttlefish and nettle, all were created by God, in the first days of creation, in their present form. We now know that such was not the case. The forms of animals and plants are not such as the Lord of creation designed to make them. And the animals and plants now living on earth

are quite different from those of other days; we still find skeletons or impressions in the rock, or remnants in the ice, of the huge beasts and plants of bygone ages: gigantic flying beasts covered with scales (pterodactyls), huge horse-tails and ferns (whole forests, later petrified into anthracite coal, a remnant of the primeval forests of prehistoric days), veritable monsters, such as ichthyosauri, brontosauri, iguanadons, etc. All these once existed and are now extinct. But we then had no fir-trees, birches, cows or sheep, in a word, 'all is changing under our zodiac'. What is more, there were no humans, for the latter developed from hairy semi-apes not very long ago. We no longer marvel at the changes that have taken place in the forms of animals and plants. But it should surprise still less that we ourselves may outdo the Almighty in this field: any good swine-herd, by an appropriate choice of food and an appropriate mating of male and female, can continue to produce new races; the Yorkshire hog, which is so fat that it cannot walk, is a creature of human effort, as is also the pineapple-strawberry, the black rose, and many a variety of domestic animals and cultivated plants. Is not man himself constantly changing under our very eyes? Does the Russian worker of the revolutionary epoch even externally resemble the Slavic savage and hunter of bygone days? The race and appearance of men are subject to change with everything else in the world.

'What is the inference? Evidently there is nothing immutable and rigid in the universe. We are not dealing with rigid things, but with a process. The table at which I am writing at this moment cannot be considered an immutable thing: it is changing from second to second. To be sure these changes may be imperceptible to the human eye or ear. But the table, if it should continue to stand for many years would rot away and be transformed into dust and this would merely be a repetition of all that has gone before. Nor would the particles of the table be lost. They would assume another form, would be carried away by the wind, would become a portion of the soil, serving as a nourishment for plants, thus being transformed, for instance, into plant tissue, etc.; there is therefore a constant change, a constant journey, a constant succession of new forms. *Matter in motion: such is the stuff of this world.* It is therefore necessary for the understanding of any phenomenon to study it in its process of origination (how, whence, why it came to be), its evolution, its destruction, in a word, its *motion*, and not its

seeming state of rest. *This dynamic point of view is also called the dialectic point of view* [34].

The word 'dialectic' comes from the Greek, and originally meant a dialogue—a verbal argument or conflict. The following quotation from Kuno Fischer indicates the meaning of Hegel's use of the word:—

'Human life resembles a dialogue in this sense that, with age and experience, our views concerning persons and things undergo a gradual change, like the opinions of the interlocutors in the course of a lively and fruitful conversation. This involuntary and necessary change in our outlooks on life and the world is the very tissue of experience. . . . That is why Hegel, when comparing the evolution of consciousness with that of a philosophical conversation, has given it the name of dialectic, or the dialectic movement. Plato, Aristotle, Kant, each of them employed this term in an important sense peculiar to himself; but in no philosophical system has it been given so comprehensive a meaning as in that of Hegel' [35].

Not only the word 'dialectic', but also the philosophical conception of the dialectic is found to some extent in Greek literature, in the writings of Heraclitus who appears, like Hegel, to have been considerably misunderstood. 'Heraclitus (544-475 B.C.), also called the "Obscure", flourished in the commercial city of Ephesos in Asia Minor, and was one of the most prominent dialecticians of ancient times. . . . In this inconstancy of all things, in a ceaseless transformation of all being, Heraclitus beheld the general law of the universe. All things are in flux, there is nothing permanent, with the result that "we cannot step twice into the same river". The world he conceived both as war and peace, summer and winter, flux and time, satiation and hunger, etc. *Opposition*, the ruling principle of the universe, is, according to Heraclitus, inherent in all things, with the result that all of existence really constitutes a *union of opposites*' [36].

The dialectic of Hegel is fundamentally different from the dialectic of Marx and Engels in so far as it is part of an idealism called 'absolute', or 'objective' idealism. Hegel thought that the world was an unfolding or expression of one all-embracing 'Absolute Idea'. Hegel thus places thought at the basis of all reality, whether material or mental, but unlike the subjective idealists, he reconciles his idealism with the material existence of nature, of the physical universe, independent of man. Nature is assumed as the 'otherness' of the absolute idea.

'The philosophy of Hegel is idealism, but it is an idealism in which every idealistic unification has its other face in the multiplicity of existence. . . . Nature and mind in the Hegelian system—the eternal and the spiritual world—have the same origin, but are not co-equal branches. Reality, independent of the individual consciousness, there must be; reality, independent of all mind, is an impossibility . . . the idea, though fundamental, is in another sense final, in the process of the world. It only appears in consciousness as the crowning development of the mind. Only with philosophy does thought become fully conscious of itself in its origin and development' [37].

In modern British literature, Hegelian idealism makes its appearance in the writings of Bernard Shaw (in *Back to Methuselah*). Shaw's 'Life Force' is the prototype of Hegel's 'Absolute Idea', becoming conscious of itself in the course of human development.

With Hegel the dialectic is a conflict between opposites in the expression of the 'Absolute Idea'. It is thus linked up with idealism and theological mystification. Nevertheless, the germ of truth which Hegel discovered is of the utmost value in our view of the world. 'Every truth, every reality . . . is the unification of two contradictory elements' [38]. This conception Marx and Engels transformed and included in the system of philosophy which might rightly be called *modern materialism*.

A summary of the Hegelian dialectic is given by Ryazanov as follows: 'He [Hegel] viewed and explained the cosmos as a continuous process of unfoldment. There is nothing immobile. The Absolute Idea lives and manifests itself only in the process of uninterrupted movement, development. Everything flows, changes, and vanishes. The ceaseless movement, the eternal unfoldment of the Absolute Idea determines the evolution of the world in all its aspects. . . . In each phenomenon, in each object, there is the clash of two principles, the thesis and the antithesis, the conservative and the destructive. This struggle between the two opposing principles resolves itself into a final harmonious synthesis of the two. . . . The conflict between the two contradictory elements included in the antithesis creates movement, which Hegel, in order to underline the element of conflict, styles *dialectic*' [39].

Let us take Marx's own words in describing his transformation of Hegel's dialectic into the framework of materialism. In the preface to the second edition of *Capital*, Marx wrote :

'My own dialectic method is not only fundamentally different from the Hegelian dialectic method, but is its direct opposite. For Hegel, the thought process (which he actually transforms into an independent subject, giving to it the name of "idea") is the demiurge (creator) of the real; and for him the real is only the outward manifestation of the idea. In my view, on the other hand, the idea is nothing other than the material when it has been transposed and translated inside the human head. Nearly thirty years ago, when Hegelianism was still fashionable, I criticized the mystifying aspect of the Hegelian dialectic. Although in Hegel's hands dialectic underwent a mystification, this does not obviate the fact that he was the first to expound the general forms of its movement in a comprehensive and fully conscious way. In Hegel's writings dialectic stands on its head. You must turn it right way up again if you want to discover the rational kernel that is hidden away within the wrappings of mystification. In its mystified form, dialectic became the fashion in Germany because it seemed to elucidate the existing state of affairs. In its rational form it is a scandal and an abomination to the bourgeoisie and its doctrinaire spokesmen because, while supplying a positive understanding of the existing state of things, it at the same time furnishes an understanding of the negation of that state of things and enables us to recognize that the state of things will inevitably break up; it is an abomination to them because it regards every historically developed social form as in fluid movement, as transient; because it lets nothing overawe it but is in its very nature critical and revolutionary' [40].

We can now see more clearly how dialectic materialism differs from the old crude 'metaphysical' materialism of the eighteenth century, and of Büchner, Vogt and Moleschott. 'The metaphysician', wrote Engels, 'regards things and concepts as distinct, unchangeable, rigid objects, given once and for all, to be examined one after another, each independently of the others'. The dialectician, on the contrary, regards things and concepts 'in their connection, their interlacement, their movement, their appearance and disappearance'.

The old metaphysical materialism, sometimes called 'mechanical' materialism, regarded abstractions as separate and distinct substances. It treated partial and ideal attributes as varieties of objective reality. A sample of it is given by Professor Eddington in *Science and the Unseen World*. Discussing

the connection between mind and brain, Eddington says:—

‘Let us for a moment consider the most crudely materialistic view of this connection. It would be that the dance of atoms in the brain really constitutes the thought, that in our search for reality we should replace the thinking mind by a system of physical objects and forces, and that by so doing we strip away an illusory part of our experience and reveal the essential truth which it so strangely disguises’ [41].

This is typical of the faults of the old materialism.

Dialectic materialism rejects these faults, and regards our abstractions and ideal attributes as relative knowledge, representing in the form of mental ‘mirror-reflections’ the concrete existence of objective reality.

The essential feature of dialectic materialism is its recognition of the absolute truth that nature, the physical world, exists as a reality apart from human perception and consciousness. This view is also called *realism* by some writers. For example, in the *Encyclopædia Britannica* we read: ‘The modern application of the term (realism) is to the . . . doctrine that *there is a reality apart from its presentation to consciousness*. In this sense it is opposed to idealism, whether the purely subjective or that more comprehensive idealism which makes subject and object mutually interdependent’ [42].

Professor Einstein, in a letter to the author (18.3.30), states that: ‘All physics is *realistic* in so far as it starts from the hypothesis of a *reality independent of perception and thought*’.

However, while recognizing the identity of these views with the chief feature of materialism, we do not use the term realism on account of its association with the definitely idealistic doctrines of other writers. For example, the subjective idealist, Professor J. S. Haldane, terms his philosophy ‘spiritual realism’, and Professor A. N. Whitehead uses the term ‘provisional realism’ for *his* concoction of mysticism and idealism. Berkeley’s subjective idealism was termed ‘Natural Realism’ by Fraser, who edited his works (1871). There are many interpretations of realism, which is a favourite name with philosophers whose assumptions are far from being realistic. For this reason we use *materialism* for the theory that there is a reality, apart from perception and thought. Furthermore, we add *dialectic* materialism, to distinguish modern materialism from the crude and faulty theories of past materialists.

To make quite clear the distinction between the old meta-

physical materialism and modern dialectic materialism we shall quote Professor A. N. Whitehead, who refers to 'the fixed scientific cosmology which presupposes the ultimate fact of an *irreducible* brute matter, or material, spread through space in a flux of configurations'. He says: 'In itself such a material is senseless, valueless, purposeless. It does just what it does do, following a fixed routine imposed by *external* relations which do not spring from the nature of its being. It is this assumption that I shall call "scientific materialism". Also it is an assumption which I shall challenge as being entirely unsuited to the scientific situation at which we have arrived' [43].

Whitehead is quite unjustified in calling this eighteenth century materialism 'scientific' materialism. As Ryazanov (formerly director of the Marx-Engels Institute, Moscow) points out, matter is not something ponderous and crude: 'For a hundred and fifty years we have been learning (through science) that matter is incredibly ethereal and mobile' [44]. Science has shown that matter is not irreducible, but is made up of electric charges possessing mass and inertia. It is thought that matter of the stars may actually be transformed into energy in the process of stellar radiation [45]. Matter is not a 'brute' material, moved here and there by 'external relations which do not spring from the very nature of its being'. On the contrary, it is from the very nature of its being that matter—in various forms—'does just what it does do'.

Hence Professor Whitehead's 'scientific materialism' is certainly not scientific, and just as certainly is not modern materialism.

Chapter III

THE 'STUFF' OF THE WORLD

I SHADOWS AND SYMBOLS

IN the early days of science it was thought impossible that the nature of the stars should ever be known. Nowadays more is known about the composition of the stars than about a number of things on earth. Among those who have contributed to this knowledge is the late Professor Eddington. In his *Nature of the Physical World* (Gifford Lectures, 1927-28), he deals with aspects of physics, but the main theme of the book is a philosophical one.

We may at once put Eddington in that class of idealist philosophers who at least may claim the honour of being in lineal descent in their opinions from Bishop Berkeley. Bishop Berkeley's famous dictum was: 'To be, is to be perceived'! He asserted that perception was at the basis of existence. According to him, the world with its objects does not exist apart from the perceiving mind. Berkeley's philosophy leads straight to solipsism, that is, to the belief that the world exists only in the mind of the philosophising individual. 'The world is my idea,' or my illusion, sums up the conclusion of solipsism.

Now this is the point at which Professor Eddington arrives, as well as J. S. Haldane, A. N. Whitehead and Bertrand Russell. Strange to say, none of these writers appear to relish the idea of being convicted of solipsism. They are at great pains to point out their removal from this position. Nevertheless, they do align themselves with Bishop Berkeley. It is granted that their realization of this at times seems to cause a flight from solipsism almost indecent in its haste. Yet the flight is only apparent, for a denial of solipsism on one page is followed by solipsism on another.

The idealism of our scientist-philosophers naturally leads also to mysticism and religious affirmations. Professor Eddington takes it upon himself to defend mysticism—in a work which pretends to expound results of science in plain language! Discussing the use of the word 'reality', he says: 'We all know there are regions of the human spirit untrammelled by the world of physics. In the mystic sense of the creation around us, in the

expression of art, in the yearning towards God, the soul grows upward and finds the fulfilment of something implanted in its nature. The sanction for this development is within us, a striving born with our consciousness or an Inner Light proceeding from a greater power than ours. Science can scarcely question this sanction, for the pursuit of science springs from a striving which the mind is impelled to follow, a question which will not be suppressed. Whether in the intellectual pursuits of science or in the mystical pursuits of the spirit, the light beckons ahead and the *purpose* surging in our nature responds. Can we not leave it at that? Is it really necessary to drag in the comfortable word "reality" to be administered like a pat on the back'? [1]. There is certainly no need for Professor Eddington to drag in the word 'reality' anywhere, for as we shall see, his 'reality' is just as unreal, just as unsubstantial, as the above mystical conceptions.

To begin with, we are repeatedly told that the scientific world 'is a world shadowing a world familiar to our consciousness'. This statement will be received with justifiable scorn by scientists engaged every day in dealing with concrete scientific problems. But people uninitiated into scientific terminology may take it that the world of science after all only deals with shadowy representations of what the ordinary person can easily grasp with his senses. Other passages show that as regards the objects with which science deals, this is Eddington's actual opinion. These objects are reduced to 'metrical symbols'. For example: 'Whenever we state the properties of a body in terms of physical quantities we are imparting knowledge as to the response of various metrical indicators to its presence, and nothing more' [2]. Again, we read that the physical world is '*restricted to a complex of metrical symbols*' [3]; also, '*The whole subject matter of exact science consists of pointer readings and similar indications*' [4].

According to Professor Eddington, science does not deal with actual objects of the external world, does not attempt to understand their nature and relations; physics does not try to explore the structure of matter, but deals only with 'pointer readings', 'metrical symbols' and the like.

This is one of the ways in which an idealist tries to explain away the facts which lead to a recognition of the objectivity of the external world, and of the existence of material bodies independent of the human mind. The attempt is absurd enough, as can be shown by a consideration of a problem put forward by

Eddington himself in support of his contention that science deals only with 'metrical symbols', and not with concrete analysable material bodies.

Eddington takes the problem of an elephant weighing two tons sliding down a grassy slope, the time taken in the slide being required. He says: 'From the point of view of exact science the thing that really did descend the hill can only be described as a bundle of pointer readings' [5]. So the elephant was not a mass of living protoplasm, descending the slope and producing heat by reason of its friction with the grass! Not for exact science; says Eddington, 'From the point of view of exact science the thing that really did descend the hill can only be described as a bundle of pointer readings' (such as that of a weighing machine recording the weight of the elephant). 'Similarly the hill becomes an angle measured with protractor and plumb line, and the friction a friction coefficient ("of a kindred nature to pointer readings") The bulk of the elephant is replaced by caliper readings and its colour by various wave-lengths of light. . . . And so on until all the characteristics of the elephant are exhausted and it has become reduced to a schedule of measures' [6].

It is to be wondered whether Professor Eddington would have continued to hold these views had he been in other circumstances—say, placed as the unique representative of science on the grass in the path of the advancing elephant! If the Professor had been then studying exact science just below the elephant, would he still have regarded the 'thing' descending the hill as 'a bundle of pointer readings'? He would probably have replied yes, but we know that actually the elephant would soon have become for him two tons of flesh and bone embedding him in the grassy slope. Wait though, Eddington said that for *science* not a *scientist*, the elephant would be 'a bundle of pointer readings'. But can science exist independently of scientists? Certainly not; so exact science would also have come to an end under the elephant! Unless of course our Professor was *not* a scientist—when in the company of sliding elephants, or when delivering a Gifford lecture! Yet the Professor has caught us again, for the grassy slope is not there; it has been reduced, like the elephant, to pointer readings. Had Eddington been able to reduce himself also to a bundle of pointer readings, exact science would no doubt have been satisfied!

If some of the more serious passages of the book are taken, the full content of this type of idealist philosophy is realized.

In connection with the somewhat unfortunate example of the sliding elephant, Eddington does state what he considers to be the elements of an occurrence for a scientist. He says, 'There is always the triple correspondence:—

(a) 'a mental image, which is in our minds and not in the external world;

(b) some kind of counterpart in the external world, *which is of unscrutable nature*;

(c) a set of pointer readings, which exact science can study and connect with other pointer readings' [7].

Eddington is right when he speaks of a mental image which an individual has of something. His opinion on science and pointer readings we can return to later. Consider for the moment the second correspondence, i.e. 'some kind of counterpart to the mental image in the external world'. Eddington here takes up the agnostic standpoint, but he does not adhere to it. He says here that the counterpart in the external world to a mental image is 'of inscrutable nature'. That is to say, our mental impressions correspond to something in the external world, but what that something is we do not and cannot know. This is agnosticism, the philosophical view of the late Professor Huxley and others. It is a favourite refuge of those who wish to avoid solipsism, but are not prepared to accept materialism, which takes our mental images to be approximate copies of objects of the external world. Dialectic materialism holds that we can obtain knowledge of the actual state of the external world by the use of our senses. Agnosticism admits the existence of an external world apart from our senses, but denies that the senses can give us any knowledge of its actual state. For this poor compromise agnosticism was termed by Engels 'shamefaced materialism'.

2 'MIND-STUFF'

Eddington does not belong to the agnostic camp; he seems merely to have strayed into it in a comparatively lucid interval. The way in which he gravitates towards solipsism can best be illustrated by the following passages from his *Nature of the Physical World*, where he places emphasis on the supposed necessity for mind in the existence of reality, which he terms 'mind-stuff':—

'To put the conclusion crudely . . . *the stuff of the world* is mind-stuff. . . . The mind-stuff of the world is, of course, something more general than our individual conscious minds; but we may think of its nature as not altogether foreign to the feelings in our consciousness' (p. 276).

'*The mind-stuff is not spread in space and time*, these are but parts of the cyclic scheme ultimately derived out of it. . . : Only here and there does it rise to the level of consciousness, but from such islands proceeds all knowledge' (p. 277).

'The mind-stuff is the aggregation of relations and relata ['meeting points of the relations'] which form the building material for the physical world' (p. 278).

Eddington has already said: 'In conceiving a world which had existence apart from the measurements that we make of it, I was trespassing outside the limits of what we call physical reality' (p. 152). Now if 'the mind-stuff is not spread in space and time', as Eddington says, then it cannot be measured—that is obvious. But he also says that a world conceived of as 'apart from measurements' is 'outside the limits of what we call physical reality'. Therefore mind-stuff, which cannot be measured, cannot be included in physical reality. But 'mind-stuff', 'the aggregation of relations and relata', forms 'the building material for the physical world'. So Professor Eddington's 'mind-stuff' is outside physical reality, but is the building material of the physical world! Truly a remarkable material, calculated to gladden the heart of every idealist philosopher!

We shall not spend any more time in analysing Eddington's burlesque. It is made clear that his 'mind-stuff' is simply mind; thus: 'I certainly do not intend to materialize or substantialize mind . . . the word "stuff" has reference to the function it has to perform as a basis of world-building, and does not imply any modified view of its nature' (p. 280). We understand very well the function of 'mind-stuff' in Professor Eddington's philosophy. He might just as well have called its function *word-building* as world-building. The result would have been the same, namely another version of subjective idealism—the 'authorized' version of an eminent scientist.

'Mind-stuff', then, is not physical, but mental. Eddington would have us believe that it is not confined to individual conscious minds, but underlies all things in common. Persuasively he says: 'It is difficult for the matter-of-fact physicist to accept the view that the substratum of everything is of mental

character. But no one can deny that mind is the first and most direct thing in our experience, and all else is remote inference' (p. 281). Eddington is anxious to demonstrate the mental character of everything. What he is apparently most anxious to avoid is the admission that a mind is the result of the activity of a brain. If everything a person perceives is of mental character then it must exist in his own mind. It cannot exist in the minds of other people, or in some vague general 'mind'. When the person dies, his whole body disintegrates, and his mind must also cease to exist. If for Eddington everything has a mental character, then on his death, the world must disappear. Thus solipsism is reached; everything is of a mental character—'the world is my idea'; Professor Eddington take his place alongside Bishop Berkeley.

3 THE INFLUENCE OF ERNST MACH

Let us trace if possible the origin of Professor Eddington's subjective idealism. 'Mind-stuff' was the term coined in the latter part of last century by the British idealist, W. K. Clifford, with whom Eddington records his agreement. Ernst Mach, the Austrian physicist, considered Clifford as 'bordering very closely' [8] on his own idealist philosophy.

Take first of all Eddington's 'metrical symbols' and 'pointer readings', to which he restricts the physical world. According to his doctrine, these should be as mental in character as everything else. The measurements and pointer readings of science are particular *observations*. They enter into science as results of sense impressions, and consequently in epistemology, the theory of knowledge, they are in the same class as other observations—of trees, tables, books and of other objects. We have seen that for Eddington 'the substratum of everything is of mental character'. Eddington makes it quite plain that he regards the familiar objects of the world as primarily mental, and even illusory, but alongside this 'familiar' world he puts the world of physics which is 'shadowy and symbolic' (p. xvii). The 'symbols' of the scientific world are pointer readings and other measurements, and what these symbols stand for, physics neither knows nor cares. Such is Eddington's argument.

In thus contraposing the 'familiar' world of 'illusions' to the 'scientific' world of 'symbols', Eddington avoids being convicted of solipsism, and assumes a position of agnosticism as

regards the entities of physics (although he finally adopts an idealist position regarding the physical world also (p. 332)). Since Eddington is discussing the nature and limits of our knowledge, 'familiar' as well as scientific, it is a false distinction to separate these two. The grounds of our knowledge are the same for scientists as for other people. Both in scientific work and in everyday life it is the criterion of practice (*experiment* in science—*practice* in ordinary life) which is the chief means whereby we learn how closely our ideas represent objective reality. Eddington, however, denies the existence of objective reality (i.e. apart from mind), and in his philosophy shows the world of science as separate and special, 'shadowing a world familiar to our consciousness, by means of "symbols"'.

It is now possible to trace the connection between Eddington's philosophy and that of Mach, Poincaré and Pearson. This school, which attacked the materialism prevailing in physics, was described in 1907 by Rey, the French writer on philosophy, as follows:—

'The critical observations directed against the traditional mechanism, which was expressed in the second half of the nineteenth century, weakened the position of the ontological reality of mechanism. On the basis of these criticisms a philosophical conception of denotation vary according to schools, the conclusion sophy at the end of the nineteenth century, established itself. *Science was nothing but a symbolic formula, a method of denotation [réparage]*, and as the methods of denotation vary according to schools, the conclusion was soon reached that only that could be denoted which was previously designed by man as capable of denotation' [9].

In the preface to his work Rey says that 'The fideist and anti-intellectualist movement of the last years of the nineteenth century seek support in the general spirit of modern physics' (p. 2).

Lenin, who delivered a smashing attack on the Mach school and on other brands of idealism in his *Materialism and Empirio-criticism*, comments on Rey's account thus: 'In France those are termed fideists who rely more on faith than upon reason. By anti-intellectualism is meant the doctrine which denies the claims or pretensions of reason. Hence in its philosophical aspects, the substance of the crisis of modern physics arises from the fact that the old physics regarded its theories as "a real presentation of the material world", that is, as a reflection of

objective reality. The new movement in physics sees in scientific theory only symbols, signs, and prescriptions for practice; it denies the existence of objective reality independent of our consciousness and reflected in it. Had Rey adhered to a correct philosophical terminology, he would have said: the materialistic theory of knowledge, which had been instinctively accepted by traditional physics, was changed for an idealistic and agnostic one, and fideism availed itself of this, despite the efforts of the idealists and agnostics' (p. 217).

The conception of 'symbols' as taking the place of matter in physics was developed by Mach and his followers. According to Mach, bodies are mental symbols for complexes of sensations. He says: 'A thing is a thought symbol for a compound sensation of relative fixedness. Properly speaking, the world is not composed of "things" as its elements, but of colours, tones, pressures, spaces, times, in short, what we ordinarily call individual sensations' [10].

The French physicist, Henri Poincaré, also expressed this view in saying: 'I thus replace the world by a system of simple symbols. It is not merely by habit as a mathematician; the nature of my subject imposed this attitude on me' [11]. However, the progress of science compelled Poincaré to admit that 'The atom of the chemist is now a reality' [12].

Eddington stops short of such an admission of the reality of atoms and electrons. He says: 'If to-day you ask a physicist what he has finally made out æther or the electron to be . . . he will point . . . to a number of symbols and a set of mathematical equations which they satisfy. What do the symbols stand for? The mysterious reply is given that physics is indifferent to that; it has no means of probing beneath the symbolism. To understand the phenomena of the physical world it is necessary to know the equations which the symbols obey but not the nature of that which is being symbolized' [13].

It must be understood that Professor Eddington is referring to those physicists of whose philosophical views he approves. The views of other physicists, such as Max Planck, are different, and will be given later.

Professor Karl Pearson, who was acquainted with Mach, and was a straightforward subjective idealist, refers to 'symbols' in his *Grammar of Science*. For him science 'is a description of perceptual experience by aid of conceptual shorthand, the symbols of this shorthand being in general *ideal* limits to perceptual

processes, and as such having no exact perceptual equivalents' (p. 288). He also says: 'Nobody believes now that science *explains* anything; we all look upon it as a shorthand description, as an economy of thought' [14].

This so-called economy of thought, first propounded by Mach and Poincaré as the object of science, obtained some hold in the scientific world, attracting a number of scientists who were inclined to subjective idealism in philosophy. It is, however, rejected by Eddington, but from the standpoint of his own idealism, not for its subjective error. Eddington comments on this Machian idea as follows: 'It is quite commonly said that scientific theories about the world are neither true nor false, but merely convenient or inconvenient. A favourite phrase is that the gauge of value of a scientific theory is that it economizes thought . . . *whatever lower standards we may apply in practice we need not give up our ideals*, and so long as there is a distinction between true and false theories our aim must be to eliminate the false. For my part I hold that the continual advance of science is not a mere utilitarian progress; it is a progress towards ever purer truth. Only let it be understood that the truth we seek in science is the truth about an external world *propounded as the theme of study, and is not bound up with any opinion as to the status of that world—whether or not it wears the halo of reality . . .*' [15].

Thus Eddington 'refutes' Mach and his followers. 'Economy of thought' is good enough for the laboratory, but in the pure air of theory and philosophy we must cling to our 'ideals'. What ideals!—of approaching as nearly as possible to the truth about the actual objective world which is independent of human consciousness? Not at all, says Eddington, our ideals concern the truth about an external world '*propounded as the theme of study*', that is, the world as it is laid down by Eddington and his colleagues. Eddington definitely tells us this by saying 'The *external* world of physics is thus a symposium of the worlds presented to different viewpoints' [16].

Thus Eddington's 'ideals' boil down to seeking the 'truth' about an imaginary world subjectively created by a number of philosophical idealists!

4. 'REVELATION' AND 'FAITH'

See where this leads Professor Eddington, who says: 'Briefly the position is this. We have learnt that the *exploration of the external world by the methods of physical science leads not to a concrete reality, but to a shadow world of symbols*, beneath which those methods are unadapted for penetrating. Feeling that there must be more behind, we return to our starting point in human consciousness—the one centre where more might become known. There we find other stirrings, *other revelations (true or false) than those conditioned by the world of symbols. Are not these too of significance? We can only answer according to our conviction, for here reasoning fails us altogether*' [17].

Here is the position of the anti-intellectual fideist, naked of all knowledge save 'revelations'! Scientific conclusions then, according to Eddington, are 'revelations', 'conditioned by the world of symbols'! We are also told that God is 'real', and that, 'The crucial point for us is not a conviction of a supreme God but a conviction of the *revelation* of a supreme God' [18]. Thus God and other concepts of religion are classed along with scientific conclusions such as those concerning the reflection of light, expansion of gases, etc. All are 'revelations'! Into such depths of clerical submission has science, or rather a certain scientist, fallen. The vast majority of scientific workers will still assert what is obviously the truth, namely that science does not consist of 'revelations', but is based on the observation of external phenomena and on logical reasoning, which enables us to explore and to some extent control nature. Religion, on the other hand, is based on subjective emotions, and leads to the prostration of mankind before a mythical 'Supreme Being'.

Discussing religion, Eddington says: 'We want an answer that the soul in reaching out to the unseen world is not following an illusion. *We want security that faith and worship, and above all love, directed towards the environment of the spirit are not spent in vain. It is not sufficient to be told that it is good for us to believe this, that it will make better men and women of us. We do not want a religion that deceives us for our own good. . . . The heart of the question is commonly put in the form "Does God really exist"?*' [19].

To 'prove' that God 'really exists' Professor Eddington does religion the service, and science the disservice, of ranking together religious mysticism and scientific reasoning. Continuing

in this muddle-headed effort he says: 'The study of the visible universe may be said to start with a determination to use our eyes. At the very beginning there is something which might be described as an act of faith—a belief that what our eyes have to show us is significant. I think it can be maintained that it is by an analogous determination that the mystic recognizes another faculty of consciousness, and accepts as significant the vista of a world outside space and time that it reveals' [20].

So it is 'an act of faith' to believe that what we see with our own eyes is significant! It is not practice which teaches us the significance of what we see; it is not experiment which tells us the significance of the objects of our vision! One would think that Eddington had never heard of the method of trial and error in determining the significance of something. To say that faith reveals to us the meaning of anything is sheer dogmatic clericalism. 'The burnt child fears the fire'—by an act of faith? The schoolboy runs when he sees the cane—is his belief in its significance an act of faith? The result of a scientific experiment is checked by repetition of the experiment—would Eddington have said that the belief in the significance of the confirmed result is an act of faith? In the realm of philosophy, faith is the standby of the mystic, who flourished in the days when people believed that the earth was flat, and that disease was caused by evil spirits which could be driven out by incantation. To use the word faith to cover the conclusions of objective experience and scientific research, as well as religious belief, is a pure sophistry; it is a failure to distinguish between knowledge based on observation and reason, and theological dogma drawn from subjective emotions.

5. BERTRAND RUSSELL'S 'NEUTRAL-STUFF'

In asserting that the world consists of 'Mind-stuff', Eddington quotes Bertrand Russell's *Analysis of Matter*. The passage is worth re-quoting in full, as it summarizes much of Russell's own particular brand of idealism. Here is the passage (which refers to the nature of a brain being examined by a physiologist): 'What the physiologist sees when he examines a brain is in the physiologist, not in the brain he is examining. What is in the brain by the time physiologist examines it if it is dead, I do not profess to know; but while its owner was alive part, at least, of

the contents of his brain consisted of his percepts, thoughts, and feelings. Since his brain also consisted of electrons, we are compelled to conclude that an electron is a grouping of events, and that if the electron is in a human brain, some of the events composing it are likely to be some of the mental states of the man to whom the brain belongs. Or at any rate they are likely to be parts of such mental state . . . a percept is an event or a group of events, each of which belongs to one or more of the groups constituting the electrons in the brain. This, I think, is the most concrete statement that we can make about electrons; everything else that can be said is more or less abstract and mathematical' [21].

Bertrand Russell makes here a strangely open admission of his solipsism by the remark: 'What the physiologist sees when he examines a brain is in the physiologist, not in the brain he is examining'. A brain is a physical object. When a physiologist or anyone else sees the brain, he takes it to be an external body made up of certain material parts, knowledge of which is given by his senses. Russell, however, following Bishop Berkeley, says that what the physiologist sees is in the physiologist, and thus arrives without any delay at pure solipsism. If what the physiologist sees when examining a brain is in the physiologist, then so must all the other objects he examines. The world, for the physiologist, must exist only in his own mind. Passing over this piece of frank solipsism we come to Russell's confession that what the physiologist sees in the brain 'when it is dead' he does not profess to know. Immediately after, he says that while the owner of the brain was alive 'part, at least, of the contents' of the brain consisted of 'percepts, thoughts and feelings'.

At this, the consistent Berkeleian idealist will protest that *all* of the contents of the brain must consist of 'percepts, thoughts and feelings'. A mechanist, on the other hand, will wonder whether Russell has suddenly altered his opinions and taken mind as part of the working of a material brain. The doubt is settled in the subsequent lines, for we are told that the brain consists of electrons, and an electron 'is a grouping of events' [22]. We have been told that 'a *percept* is an event or a group of events, each of which belongs to one or more of the groups constituting the electrons in the brain'.

So electrons and percepts are both 'events'; matter and mind are thus both built up out of 'events'! Apparently mind and matter are identical. Matter 'can be regraded as a system of

events' [23]. *'A percept is one of a system of correlated events, all structurally similar or semi-similar . . . the physical world, as far as is known, consists of such events'* [24]. Surely we are near Eddington's 'mind-stuff'! Russell, however, prefers his own name—it is 'neutral-stuff'! He explains his position as follows:

'To show that the traditional separation between physics and physiology, *mind and matter*, is not metaphysically defensible, will be one of the purposes of this work; but the two will be brought together, *not by subordinating either to the other*, but by displaying each as a logical structure composed of what, following Dr. H. M. Sheffer, we shall call "*neutral-stuff*". *We shall not contend that there are demonstrative grounds in favour of this construction, but only that it is recommended by the usual scientific grounds of economy and comprehensiveness of theoretical explanation'* [25].

In this pedantic way does one idealist differ from another: the world is not made up of 'mind-stuff', but of 'neutral-stuff'! It will be noted, however, that Russell differs from Eddington in another respect, in that he takes as justification for the 'construction' of 'neutral-stuff', the fact that it is '*recommended by the usual scientific grounds of economy and comprehensiveness of theoretical explanation*'. Thus Russell accepts the view of the Machians, which Eddington rejected, in taking 'economy' as the criterion of the truth of a theory.

By accepting Mach's theory of 'economy of thought' as the function of theoretical science, Russell avoids having to contend that there are demonstrative grounds in favour of 'neutral-stuff'. Russell's view, or 'construction', is recommended (by Russell) on the grounds of 'economy'. That is enough—no proof or demonstrative grounds are needed—which is very convenient, for obviously no demonstration of 'neutral-stuff' is possible. For one thing, the 'event' of which it is apparently made up are outside space and time. Russell says: 'It is convenient to use the word "event", in the strict sense, *to mean something which, if it has a structure, has no space-time structure, i.e. it does not have parts which are external to each other in space-time*' [26].

Thus Bertrand Russell as well as Professor Eddington manage to get their 'stuff' of the physical world outside space and time, where no awkward practical tests of the nature of 'mind-stuff', 'neutral-stuff', or 'events' are possible. Here again the difference between Russell and Eddington is a pedantic one. Eddington removed the material of the physical world outside

space and time by way of mysticism. Russell removes it by arguments of 'economy'. In both cases idealism is triumphant—matter has disappeared. Abstract 'stuff' outside space and time (!) has replaced it.

At this point there is to be expected a protest from Lord Russell against the accusation of pure idealism. He admits that his views on 'the material out of which the physical world is constructed . . . have, perhaps, more affinity with idealism than with materialism' [27]. But other passages of the *Analysis of Matter* suggest a tendency towards agnosticism. For example: 'We know nothing of the intrinsic quality of the physical world, and therefore do not know whether it is, or is not, very different to that of percepts' (p. 264). Again, 'The only legitimate attitude about the physical world seems to be the one of complete agnosticism as regards all but its mathematical properties' (pp. 270, 271).

In spite of these affirmations of agnosticism, Bertrand Russell belongs no more than Eddington to the agnostic camp. He is an idealist, and necessarily gravitates towards solipsism and the company of Bishop Berkeley. Russell's path to solipsism will now be traced out, with some of the twists and turns taken in avoiding openly taking his stand as a solipsist. To begin with, Russell is somewhat alarmed, or perhaps ignorant, about solipsism, for he twists its meaning in the following manner: 'What we hear, what we read in books, comes to us entirely through a flow of energy across the boundary of our body. It may well be maintained that our direct knowledge is less than this statement would imply, but it is certainly not greater. *Two universes which give the same results for the flow of energy across the boundary of A.'s body will be totally indistinguishable for A.*

'My object in bringing up these considerations is partly to give a new turn to the argument about solipsism. As a rule solipsism is taken as a form of idealism—namely, the view that nothing exists except my mind and my mental events. I think, however, that it would be just as rational, or just as irrational, to say that nothing exists outside my body, or that nothing exists outside a certain closed surface which includes my body. Neither of these is the general form of the argument. The general form is that first given above—namely that, given any region not containing myself, two physical theories which give the same boundary conditions all over this region are empirically indistinguishable' (p. 28).

Presumably Russell means systems and not theories—for how can a theory give a physical condition? In this case Russell is saying that if the body with its sense organs (or ‘the boundary’) is affected by two physical systems (or ‘theories’) which give the same bodily results (or ‘conditions’), then the two systems are indistinguishable by the individual concerned. In other words, we depend on our bodily reactions in considering the nature of the universe. Provided the bodily reactions are the same, any other universe will lead us to the same conclusions, and be indistinguishable from the first universe. That is, the bodily reactions, or ‘boundary conditions’, of an individual form the determining factor in his conclusions, form the basis of his beliefs and go to make up the universe as it is known to him.

This is what Russell calls the ‘general argument’ of solipsism. He says that his reason for ‘bringing up these considerations is (partly) to give a “new” turn to the argument about solipsism’. Why does Russell wish to do this? From his own words it is plain that Russell is an idealist who falls into solipsism. The reason he gives this ‘new turn’ to the solipsist argument is that he already realizes his tendency towards solipsism, and so tries to save himself, not by turning honestly to materialism, but by presenting solipsism in a ‘new’ and incomplete—or rather inaccurate form.

To carry the above ‘general argument’ of Russell’s to its logical solipsist conclusion, it is necessary to point out that the body of an individual is realized to be such by his mind, which also contains the conceptions of ‘bodily reactions’, ‘boundary conditions’, universe, etc. Thus the body and its functions are perceived by *the mind, which according to the true solipsist view is the only reality*. For the solipsist, ‘To be is to be perceived’ (whatever other interpretation Bertrand Russell may choose). The body therefore exists only in being perceived. The mind is the sole reality. ‘The world is my idea’. This is solipsism, and, as we shall show, it is into this philosophical absurdity of Bishop Berkeley that Russell the idealist necessarily falls, much as he tries to avoid it by presenting it incorrectly with ‘new’ turns and arguments.

Russell’s progress towards solipsism is a hesitant one, and it is difficult to tell whether it includes more of loose phraseology or bad science. He explains at one stage, ‘The twofold character of a *physical object*’ [28], which, on the one hand, ‘is a group of ‘appearances’, i.e., of connected events’, and, on the other hand,

'has an influence upon the appearances of other objects, especially appearances in its neighbourhood' [29]. The significant thing here is that physical objects are spoken of as 'appearances', the word 'appearance' being used without inverted commas as well as with them. For Bishop Berkeley also objects were 'appearances'.

On the same page Russell explains 'the twofold location of a percept', giving a description of a light wave coming from an object to an individual and causing a percept. He says that the eye of an individual is a collection of 'centres' (of 'events'), and that 'after traversing it the process which was a light wave obeys a different set of laws. *The percept* is a term of this process, characterized by the fact that it occurs after traversing a certain region consisting of an eye, an optic nerve, and part of a brain. Owing to its casual continuity with other parts of the process, it has, as its two-fold location, on the one hand the source of light, on the other hand the brain' [30].

Whether intentionally or not, Russell here says plainly that the percept *traverses eye, optic nerve, and brain*. It will be news to physiologists to learn that what passes through eye and optic nerve is a percept. Up to the present they believe that brain is essential to the production of a percept, and that what passes through eye and optic nerve is some physical process which could not by any stretch of imagination be called a percept. Still more amazing is the statement that the percept has a 'two-fold location,' namely, on the one hand, 'the source of light', and, on the other hand, 'the brain'. It is certainly true the percept is in 'casual continuity' with the source of light, but how this gives the percept any *location* at the source of light is a mystery for a metaphysician to solve. This Lord Russell proceeds to do, with true subjective idealism.

He says: 'The usual view would be that . . . the only way to acquire knowledge of our brains is to have them examined by a physiologist after we are dead, which seems somewhat unsatisfactory. I should say that *what the physiologist sees when he looks at a brain is part of his own brain, not part of the brain he is examining*' (pp 382, 383). An equivalent statement to this would be: I should say that what a person sees when he looks at an object is part of his own brain, not part of the object he is examining. Russell puts aside the main question of whether *any* perceived object really exists outside the 'brain' (read *mind*) of the perceiving individual, by calling the latter 'a physiologist',

and taking a brain as the particular object perceived. Even so, subjective idealism is clearly expressed.

A second passage shows clearly Russell's solipsism. He writes: 'The behaviour of *the percepts we call other people's bodies* is similar to that of our own body to this or that stimulus' (p. 204). We have been told that what an individual (a 'physiologist') sees when he examines an object (a 'brain') is in his own mind ('brain'). Now we are told that other people's bodies are percepts—in the mind, therefore, of the individual who perceives them. Solipsism could hardly be more plainly expressed, although Russell does substitute 'brain' and 'bodies' for Berkeley's 'houses', 'mountains' and 'rivers'. In both cases natural objects are said to be 'percepts'. If natural objects are percepts, then they exist only in the mind of a perceiving individual. The philosopher who maintains this reaches the solipsist conclusion: The world exists only in his own mind.

Lord Russell has no wish to be seen as a follower of Bishop Berkeley, and so he takes what may be called a flight from solipsism. He proceeds to 'distinguish' his philosophy from Berkeleian idealism. His methods include (1) presenting solipsism incorrectly; (2) condemning Berkeleian arguments; (3) using materialist phraseology—matter, physical world, etc.; (4) pretending to lean towards materialism as regards natural law.

Take for example the following conclusion: 'I conclude, then, that there is no ground for excluding percepts from the physical world, but several strong reasons for including them' (p. 384). One might think that this was a materialist writing, tolerantly allowing percepts and mind a place beside matter in the universe. Can this be the same philosopher who previously referred to 'the percepts we call other people's bodies'?

Russell's temporary agnosticism has already been mentioned. He uses this refuge again in the latter part of his *Analysis of Matter* in saying: 'We have not suggested that all reality is mental. The positive arguments in favour of such a view, whether Berkeleian or German, appear to me fallacious. The sceptical argument of the phenomenologists [agnostics], that, whatever else there may be, we cannot know it, is much more worthy of respect' (p. 388). Russell, who arrives at solipsism, condemns the arguments of Berkeley, its chief advocate!

After all, though, Russell's attempt at escape from solipsism is but a half-hearted one. He again presents solipsism incompletely by saying: 'Solipsism, as an epistemologically serious theory,

must mean the view that from my percepts there is no valid method of inferring the character, or even the existence of other percepts'. He then continues: 'If inference is taken in the sense of strict deductive knowledge, there is, so far as I can see, no escape from the solipsist position. . . . We cannot escape from the solipsist position without bringing in induction and causality, which are still subject to the doubts resulting from Hume's sceptical criticism. Since, however, all science rests upon induction and causality, it seems justifiable, at least pragmatically, to *assume* that, when properly employed, they can give at least a probability' (p. 398).

In this equivocation Russell reduces the soundness of his grounds for rejecting solipsism to a probability. He then retreats further from his rejection of Berkeleian arguments by saying: 'I have made this assumption [i.e. that induction and causality can give a probability of the existence of things outside and independent of a perceiving individual] baldly, without attempting to justify it; . . . while I am convinced that a justification is possible, *I am not satisfied with those put forward by others or with any that I have been able to invent myself*' (pp. 398, 399). Here Russell tells us that he is unable to justify his assumption of the probability that induction and causality provide an escape from solipsism! Thus his 'rejection' of solipsism (Berkeleian arguments are 'fallacious') amounts to a conviction that it is false, but a conviction which he cannot justify. So Russell's flight from solipsism is in a circle! Our mathematician lost in the wilds of idealist philosophy has wandered back to the point of solipsism. Nevertheless he is 'convinced' that he has avoided it! This is his profound conclusion after beating about the bush in four hundred pages of intricate 'analysis!'

Chapter IV

THE 'FAITH' OF PHILOSOPHERS

1 THE 'ABSTRACTIONS' OF PROFESSOR WHITEHEAD

IT has been seen how Bertrand Russell got rid of matter in his philosophy by substituting 'events', which were said to include both percepts and matter. By a similar feat of philosophical juggling another mathematician, Professor A. N. Whitehead, brings non-material 'objects' out of his professorial hat. These he also christens 'events', and proclaims to his audience that these non-material 'events' are the only ultimate reality. These 'scientific' results of Professor Whitehead's 'scientific' thought are recorded in a 'scientific' book called *Science and the Modern World* (Cambridge University Press, 1927). Here we might expect to find something about the realities of nature. What we actually do find is Professor Whitehead explaining what he means by 'events', 'prehensions', 'aspects', 'patterns', 'organic mechanism'—and 'God'.

Take first the 'events'. We are told that 'the event is the unit of things real' (p. 189); also that we must start with the event as 'the ultimate unit of natural occurrence' (p. 129). An event may be considered as 'the most concrete finite entity' (p. 160). So much for definitions of an 'event'. Turn now to the theory of 'organic mechanism'.

Whitehead announces: 'I would term the doctrine of these lectures the theory of organic mechanism . . . this doctrine involves the abandonment of the traditional scientific materialism, and the substitution of an alternative doctrine of organism' (p. 99). The significance of this announcement is realized when one remembers what has been gained by work based on 'the traditional scientific materialism'. From the earliest days of science materialism has been the instinctive attitude taken up by scientists in their work, whatever additional theological or idealist trappings have been carried. In the face of tremendous opposition from mystics, priests, etc., scientific materialism has provided the basis for the creation of modern medicine, astronomy and navigation, chemistry and industry; for those comforts and amenities which Professor Whitehead no doubt

enjoys. Scientists, whatever philosophical or theological views they have held apart from their work, have adopted in practice the belief that material objects exist independently of human minds, which give approximately correct images of what actually exists externally. For example, the whole atomic theory, with its innumerable demonstrative proofs, has been built up on the conception that the world consists of matter in motion. Modern medicine was built up on the principle that many diseases are caused by germs, i.e. by material bodies which are not spontaneously generated out of nothing, but which are part of developing organic matter.

Even Professor Whitehead admits the success of materialism as a guide to discovery and technical progress. About 'the characteristic scientific philosophy which closed the seventeenth century' he says: 'In the first place, we must note its astounding efficiency as a system of concepts for the organization of scientific research. . . . It has held its own as the guiding principle of scientific studies ever since. *It is not only reigning, but is without a rival*' (p. 69). This is the testimony of an idealist to the efficiency and success of scientific materialism! But this does not satisfy such a seeker after truth as Professor Whitehead. The fact that scientific materialism has been a successful guiding principle in practice does not convince him of its truth, for he adds: '*And yet it is quite unbelievable. This conception of the universe is surely framed in terms of high abstractions, and the paradox only arises because we have mistaken our abstractions for concrete realities*' (p. 69).

This is typical of those scientists who produce long rigmaroles of subjective idealism. The jump from theory to practice becomes too much for them. Scientific proof loses its value for them. They seek for 'higher' truth in the realm of philosophy, which shall not be contaminated with gross materialism. They tell materialists that their philosophy is 'unbelievable'. If asked why materialism is unbelievable they point to their own long-winded discussions on why matter is not matter. We shall indicate Professor Whitehead's philosophy along certain lines in endeavouring to trace his arguments to intelligible conclusions. Unfortunately, it will not be possible to avoid inflicting on the reader the final obscure jumble of words.

'What is matter made of?' asks Whitehead, and answers himself as follows: 'The answer is couched in terms of stuff, or matter or material—the particular name chosen is indifferent—which

has the property of simple location in space and time. . . . *What I mean by matter, or material, is anything which has this property of simple location.* By simple location I mean one major characteristic which refers equally both to space and time . . . that material can be said to be *here* in space and time, or *here* in space-time, in a perfectly definite sense which does not require for its explanation any reference to other regions of space-time' (pp. 61, 62). Having defined what he means by matter, namely that which has the property of 'simple location', Whitehead goes on to demolish the puppet he has set up by rejecting the idea of 'simple location'. He says. 'I shall argue that among the primary elements of nature as apprehended in our immediate experience, *there is no element whatever which possesses this character of simple location* . . . I hold that by a process of constructive abstraction we can arrive at *abstractions which are the simply-located bits of material*, and at *other abstractions which are the minds* included in the scientific scheme. Accordingly, the real error is an example of what I have termed: The Fallacy of Misplaced Concreteness' (p. 72).

Thus 'by a process of constructive abstraction', Whitehead has demolished the concrete, has annihilated matter. Those material bodies ('simply located bits of material'), such as chairs, tables, etc., which we regard as concrete things, are, according to Whitehead, only abstractions. A person may knock his arm on a table, which he proceeds to talk about, believing it to be something concrete. He is mistaken, according to Professor Whitehead, who says that 'although there are entities left corresponding to the entities we talk about, yet these entities are of a high degree of abstraction' (p. 66). This table is 'of a high degree of abstraction'. Professor Whitehead's 'abstractions' appear to resemble the entities of Professor Eddington's 'shadow world'. Both Professors have done away with matter external to and independent of mind. Eddington has reduced it to 'shadows'; Whitehead has reduced it to 'abstractions'. Russell replaced it by 'events', while for Whitehead 'the event is the unit of things real.' Each learned philosopher invents his own phrases and parades his own doctrine. On one thing only are they agreed—matter must go, materialism must be refuted!

In elaborating his 'theory of organic mechanism' in *Science and the Modern World*, Whitehead not only makes gross blunders regarding scientific ideas, but also concocts the most trumpery

absurdities of metaphysical speculation. It will be noted that the title, 'organic theory of mechanism', suggests a materialist view. This is a favourite device of modern idealists—materialist terminology covers subjective idealism. Whitehead announces: '*I have sketched an alternative philosophy of science in which organism takes the place of matter.* For this purpose, the mind involved in the materialist theory dissolves into a function of organism' (p. 241). This is a blend of materialist phraseology and idealist nonsense. Mind *is* a function of an organism, such as man, possessed of a well-developed brain, but for Whitehead 'organism' has a very different meaning to the generally accepted one. 'Organism', he tells us, takes the place of matter (whereas in science organic matter is a particular kind of matter). An organism, for science, is that with which biology deals, namely, 'an individual constituted to carry on the activities of life by means of parts or organs . . . *any living being: any animal or plant*' (Webster's International Dictionary). The word 'organism' may be used in another metaphysical sense meaning 'possessed of a complex structure'. Whitehead is attempting to replace the scientific meaning of organism by a metaphysical one, *while all the time dealing with the subject matter of science, with atoms, matter, etc.* Whitehead replaces matter by 'organism' (which for science is a particular form of matter) and substitutes the metaphysical for the scientific meaning of that word. Then—hey presto! matter had disappeared, only 'events' and organisms' are left! A remarkable feat!

Let us try to find out what Whitehead's 'organisms' are! We learn that our bodily 'event' is an unusually complex type of 'organism' (p. 241). Our body, of course, has disappeared—only our 'bodily event' is left. We also learn that: 'Science is taking on a new aspect which is neither purely physical, nor purely biological. It is becoming the study of organisms. Biology is the study of the larger organisms; whereas physics is the study of the smaller organisms. . . .' (p. 129). Thus biologists and physicists are jerked willy nilly into Professor Whitehead's high philosophical sphere of knowledge! In *Symbolism*, another of Whitehead's books, 'organisms' are also referred to, and are said to include electrons as well as men (p. 33). Biologists and physicists will have little liking for Professor Whitehead's juggling with scientific words in the interests of idealism. They will certainly keep their own interpretation of 'organism', and leave the professor to his philosophical word games. We must now plunge

into the fog of Whitehead's 'philosophy', if only to realize how dense it is.

2. THE 'THEORY OF ORGANIC MECHANISM'

The following is a typical example of the meaningless jumble found in *Science and the Modern World*. It sets out the 'theory of organic mechanism':—

'Physical entities may be modified in very essential ways, so far as these laws are concerned [i.e. laws of physics]. It is even possible that they may be developed into individualities of more fundamental types, with wider embodiment of envisagement. Such envisagement might reach to the attainment of the poising of alternative values with exercise of choice lying outside the physical laws, and expressible only in terms of purpose. Apart from such remote possibilities, it remains an immediate deduction that an individual entity, whose own life-history is a part within the life-history of some larger, deeper, more complete pattern, is liable to have aspects of that larger pattern dominating its own being, and to experience modifications of that larger pattern reflected in itself as modifications of its own being. This is the theory of organic mechanism'! (p. 134).

So this is what Professor Whitehead offers in return for the abandonment of scientific materialism! Is the reader any the wiser for it? If not, then let us look for definitions of some of the words used in the rigmarole. What is 'value' for instance? Whitehead says: 'Value is the word I use for the intrinsic reality of an event. . . .' (p. 116). What then is an event? It is, among other things, 'a grasping of diverse entities into a value'! (p. 130). As this unfortunate tautology does not make us any the wiser, let us be fair to Professor Whitehead and take another definition—for example: 'an event is the grasping into unity of a pattern of aspects' (p. 149). Aspects of what?—it may be asked. Apparently when the word 'aspects' is used it refers to aspects of 'eternal objects'; we read earlier: 'The aboriginal data in terms of which the pattern weaves itself are the aspects of shapes of sense objects and of *other eternal objects*' . . . (pp. 187, 188). Now it is only necessary to find out what eternal objects are, and the riddle is solved.

It is not surprising to learn that 'eternal objects' are, 'in their nature, abstract'. In 'explanation' Whitehead then describes

two 'principles' in connection with 'eternal objects'. The description is given at length, not with any idea of shedding light on previous professorial wisdom, but to expose one method of concealing subjective idealism, namely by spreading over everything a thick, impenetrable fog of metaphysical jargon. Here is the passage :—

"The first principle is that *each eternal object* is an individual which, in its own particular fashion, is what it is. This particular individuality is the individual essence of the object, and cannot be described otherwise than as being itself. Thus the individual essence is merely the essence considered in respect to its uniqueness. Further, the essence of an eternal object is merely the eternal object considered as adding its own unique contribution to each actual occasion. This unique contribution is identical for all such occasions in respect to the fact that the object in all modes of ingression is just its identical self. But it varies from one occasion to another in respect to the differences of its modes of ingression. Thus the metaphysical status of an eternal object is that of a possibility for an actuality. Every actual occasion is defined as to its character by how these possibilities are actualized for that occasion. Thus actualization is a selection among possibilities. More accurately, it is a selection issuing in a graduation of possibilities in respect to their realization on that occasion. This conclusion brings us to the second metaphysical principle; an eternal object, considered as an abstract entity, cannot be divorced from its reference to actuality generally, though it is disconnected from its actual modes of ingression into definite actual occasions. This principle is expressed by the statement that each eternal object has a "relational essence". This relational essence determines how it is possible for the object to have ingression into actual occasions. In other words: If A be an eternal object, then what A is in itself involves A's status in the universe, and A cannot be divorced from this status. In the essence of A there stands a determinateness as to the relationships of A to other eternal objects, and an indeterminateness as to the relationships of A to actual occasions. Since the relationships of A to other eternal objects stand determinately in the essence of A, it follows that they are internal relations. I mean by this that these relationships are constitutive of A, for an entity which stands in external relations has no being as an entity not in the relations' (pp. 198, 199).

This incredible flow goes on for several pages. Thus 'events' are 'patterns of aspects'; 'aspects' are of 'eternal objects'; and 'eternal objects' are what Professor Whitehead says they are! All is as clear as mud.

In spite of the jumble of words which fills up *Science and the Modern World* it is possible to expose Whitehead's solipsism. Referring to Bishop Berkeley's *Principles of Human Knowledge*, Whitehead says Berkeley contends: 'That what constitutes the realization of natural entities is the being perceived within the unity of the mind' (p. 87). Whitehead then adds —

'We can substitute the concept, that the realization is a gathering of things into the unity of a prehension, and that what is thereby realized is the prehension and not the things. . . . For Berkeley's mind, I substitute a process of prehensive unification' (p. 87). Whitehead's 'substitution' is of small importance, for 'prehension' means '*apprehension*'. He says: '*I will use the word 'prehension' for uncognitive apprehension: by this I mean apprehension which may or may not be cognitive*' (p. 86). Now an apprehension is a mental process of an individual, and it makes no real difference if Whitehead substitutes a mental process of apprehension for Berkeley's 'mind'. What Whitehead says is that the realization of natural entities, i.e. nature, is the realization of a 'prehension', that is, of something mental in character. This is not really different from Berkeley, who said that the realization of natural entities was the being perceived within the unity of the mind. Each is solipsism; for each the world (or 'natural entities') exists only in the mind, or in a mental process, which must of necessity be that of an individual.

Having learnt that a 'prehension' is an apprehension (i.e. a mental process), we can understand how complete is Whitehead's subjective idealism, beneath its disguise of obscure terms. We find that 'event' is synonymous with 'prehension' (it may be used instead of the term 'prehension' (p. 91). Also, 'the event is the unit of things real' (p. 189). So we find that reality ('events' or 'prehensions') is mental in character! According to Whitehead, then, the materialist who takes physical reality to be something independent of mind (in which it is approximately reflected) is making a mistake. But this materialist view is held by the majority of people, who have no trouble in avoiding the logical lunacy of philosophical idealism.

In common with other modern idealists Whitehead shares

the desire to appear as something else: he himself adopts the position of 'provisional realism' (p. 80). Later, he has the boldness to say: 'In these lectures I am giving the outline of what I consider to be the essentials of an objectivist [!] philosophy adapted to the requirements of science [!] and to the concrete experience of mankind. Apart from the detailed criticism of the difficulties raised by subjectivism in any form, my broad reasons for distrusting it are three in number. . . .' (p. 10) Whitehead, the subjective idealist, 'distrusts' subjectivism! Subjective idealism maintains that the world does not exist apart from mind. This is what Professor Whitehead actually maintains. But he covers up his subjectivism by using his own special vocabulary. Such words as 'organism', 'event', 'aspect', 'eternal object', and 'prehension' serve to disguise this follower of Bishop Berkeley as a 'provisional realist'. He is thus able to talk about 'science' and the modern world with the voice of modern 'authority'.

3 FROM IDEALISM TO RELIGION

Professor Whitehead's passage from subjective idealism to religion is an easy one. The fact that religion is dealt with in *Science and the Modern World* is not surprising, for Whitehead's 'science' is of a very peculiar kind, as will be shown later in more detail. For the present, it is sufficient to note its alliance with religious conceptions. Whitehead treats science similarly to Eddington, namely, as something in the nature of a 'revelation'. Eddington speaks of the study of the universe as beginning with 'something which might be described as an act of faith'. Whitehead in *Science and the Modern World* says that science 'has remained predominantly an anti-rationalistic movement, based upon a naive faith. What reasoning it has wanted has been borrowed from mathematics. . . .' (p. 20). This is part of the misrepresentation of science that Whitehead is constantly making. Like Eddington, he puts scientific observation on a basis of 'faith', and thus brings it down to the same level as religious ideas, which are based on faith. So science and religion are 'reconciled'!

The sophistry of such arguments from well-known writers must be ruthlessly exposed. Science is *not* based on 'faith'; it is based upon observation and experiment. No amount of

specious argument on the part of idealist philosophers can remove this fact.

The question Whitehead raises about the basis of science is epistemological, that is, it concerns the grounds of our knowledge. Scientific questions, on the other hand, concern primarily the interpretation of specific observations and experiments. Whitehead chooses not to distinguish between science and the theory of knowledge. For example, he says that science '*has never cared to justify its faith or to explain its meanings, and has remained blandly indifferent to its refutation by Hume*' (p. 20). The answer to this is that science has amply justified its 'faith' by its immense success in being able to predict events, to harness the forces of nature, and to provide the possibility of releasing mankind from the ceaseless drudgery of purely manual toil. As to the assertion that science (while remaining 'blandly indifferent') has been refuted by Hume, the philosopher of scepticism, that is the height of absurdity. No philosopher, no epistemological theory, could refute science, any more than Whitehead could refute Darwin by saying that two and two make five. What philosophers like Professor Whitehead *can* do, however, is to cause confusion by not distinguishing between epistemology and natural science. Also, the idealism and mysticism of Eddington, Whitehead and Co. can obscure the paths which science has yet to explore by referring to problems as 'unknowable', and under the control of 'God', or outside the domain of science. The problems of how mind developed as a function of organized matter, of the workings of the brain, of all life processes, are problems to be probed by science on the basis of materialism, which is the basis the great majority of scientists instinctively adopt.

The mistake of confusing epistemological with scientific problems will be avoided by all those who are not submerged in the subjectivism and mysticism of academic circles. The grounds of our knowledge is an epistemological question, only to be correctly answered by the use of dialectic materialism when amplification of the answer can be derived from scientific discovery.

Whitehead is a mathematician who treats problems of physics and also philosophy. To bolster up his philosophical idealism he uses arguments connected with scientific theory. The fallacies will be dealt with later. For the moment the important thing is that Whitehead, as a religious believer, is misrepresenting science

in attempting to justify religious faith. In addition to connecting ambiguously the word 'faith' with the conclusions drawn from scientific observation Whitehead also connects science with 'God' by the use, or rather misuse, of the word 'rationalistic'. In the above quotation science is said to be 'predominantly an anti-rationalistic movement'. Again, speaking of what he calls the 'historical revolt', comprising the early growth of science, Whitehead says: 'It was a very sensible reaction, *but it was not a protest on behalf of reason*' (p. 20).

The word 'rationalism' is applied to theological doctrines of the Middle Ages. When Whitehead speaks of science as predominantly an anti-rationalistic movement', he is referring to the opposition of science to the philosophical and theological teaching of that time. He says that science was anti-rationalistic 'because the rationalism of the scholastics required a sharp contact with brute fact' (p. 22). Science did make contact with 'brute fact', and was opposed to the rationalism of the religious teachers. This rationalism was the teaching that 'reason' is the foundation of religion. Obviously the 'reason' of the medieval-rationalists is not our conception of reason.

This is but the thin end of the wedge of Whitehead's religious propaganda. The insertion of the wedge is the statement that the 'historical revolt' of science 'was not a protest on behalf of reason' (p. 20). Here Whitehead suggests that the conflict between science and medieval theology was not a conflict between reason and religious doctrines, that it was not reason which attacked theology, but the 'brute facts' of science. This gives a misleading impression of science, which does not merely collect facts. The truth is that reason (in its ordinary sense) is an essential element of science, and entirely opposed to religion. Whitehead has merely made a concealed attempt to put reason on good terms with religion.

The significance of all this is realized on coming to Whitehead's chapter on 'God' in *Science and the Modern World*, where the existence of 'God' is discussed with reference to 'reason'. We are told that, 'No reason can be given for the nature of God, because that nature is the ground of rationality' (p. 222). Thus, while in Whitehead's earlier chapter, 'The Origins of Modern Science', we learnt that religious dogma did not receive 'a protest on behalf of reason' from science, in the later chapter on 'God' we are further informed that the nature of 'God' is 'the ground of rationality'. First religion is protected from the buffetings of

reason and then 'God' is suggested as the ground of rationality, that is, as the basis of reason! Obviously in that case 'No reason can be given for the nature of "God",' and it can logically be said that 'His existence is the ultimate irrationality' (pp. 222, 223). The verbal juggling is now complete, and God has been introduced as a result. First science is said to be 'anti-rationalistic', and then 'God's' existence is said to be 'the ultimate irrationality'. Science and religion are thus 'reconciled'.

Professor Whitehead's view of religion is given in a series of paradoxes which end with an expression of unconcealed anti-intellectual fideism. The paradoxes form a mystical religious formula which commits Whitehead to nothing because of its very paradoxical nature. When subjected to a critical analysis the following description reduces itself to pure nonsense:—

'Religion is the vision of something which stands beyond, behind, and within, the passing flux of immediate things; something which is real, and yet waiting to be realized; something which is a remote possibility, and yet the greatest of present facts; something that gives meaning to all that passes, and yet eludes apprehension, something whose possession is the final good, and yet is beyond all reach; something which is the ultimate ideal, and the hopeless quest' (p. 238).

Following on this preliminary paradoxical formula, which resembles some medieval incantation, Whitehead reveals the religious obscurantism which is a consequence of his subjective idealism. He says: 'The vision claims nothing but worship; and worship is a surrender to the claim for assimilation, urged with the motive force of mutual love' (p. 238). The vision claims 'worship'—which is an uncritical acceptance of what appears (or is said to be) supernatural. Worship is the attitude which has been adopted in the past to the 'animal spirits' of trees and stones, to carved idols, to mythical 'pagan' gods, and to Jehovah, Buddha, Allah, etc. It was the attitude urged on people by the Christian Church towards 'God' and his 'works' (the phenomena of nature), in the days when the Inquisition flourished and scientific thinkers perished for daring to analyse 'divine' creation. The killing of Bruno, the threatening of Galileo, the persecution of Roger Bacon, the opposition to Simpson and anæsthetics, are all incidents in the fight of critical science against religious worship. The great advance of science in the nineteenth century drove back the Church from many of its strongholds of religious dogma. The discovery of germs as the cause of disease and the

Darwinian theory of evolution with its hosts of supporting facts are but two of the great landmarks in the driving back of religion and worship from its mythical, dogmatic interpretation of the world. It remains for Professor Whitehead and his kind to find a place for religious worship under the wing of subjective idealism, in company with a hotch-potch of pseudo-science.

Whitehead proclaims that 'the power of God is the worship he inspires'. Then, recognizing that the inspiration to worship is weak without the suitable paraphernalia of priestly ritual, he adds: 'That religion is strong which in its ritual and its modes of thought evokes an apprehension of the commanding vision' (p. 239). Let all scientists unite in providing the latest scientific devices for church ceremonies! Unless Whitehead wishes religion to remain weak this is what he must desire. *Science and the Modern World* contains no denunciation of religion, on the contrary, a number of pages devoted to mystical statements about God and religion. The above piece of priestly wisdom might have been written by any temple devotee of ancient times. In modern times ritual has diminished. Professor Whitehead's statement on religion may be taken as a hint to the clergy on how to fill their churches. It expresses the view of the anti-intellectual fideist, and to find it, with the rest of Whitehead's mystical utterances, in *Science and the Modern World* throws an interesting light on the tendency of certain scientific authorities to flirt with religious fancies in the shade of subjective idealism.

4 THE DUALISM OF A SPIRITUALIST

Religious ideas under the cloak of 'science' are also put forward by Sir Oliver Lodge, whose philosophy is of a different variety to that of Professor Whitehead, but, like the latter's, it covers religious doctrines mixed up with ideas borrowed from science.

Concerning the problem of mind and matter Lodge has said in his *Science and Human Progress*: 'tentatively and temporarily, we must recognize and attempt to formulate a sort of duality' (p. 29). Later, he goes on to say that 'if what I hold is true, the body is a serviceable subordinate to the spirit of man. The spirit and all that it involves is a permanent entity, which makes use of the properties of matter, *not as essential to its existence*, but as instrumental aids essential to demonstration' (pp. 155, 156).

This conception of 'spirit' capable of existing independently of the body is characteristic of the spiritualists. With a complete disregard of the facts of evolution, comparative anatomy, and physiology, Lodge considers material phenomena to be 'manifestations' of mind. Thus: 'Memory does not reside in the brain; nor does the matter of the brain think and plan and feel. These attributes do not belong to matter; they only utilize matter for purposes of demonstration or manifestation. If the machine is injured manifestation ceases' (p. 87).

This dualist concept of mind or 'spirit' existing independently of matter and working its will through the medium of the human body was formed in very ancient times. The early source of its influence on European thought was Alexandria in the 3rd century A.D., with its blends of Platonic philosophy and various mystical doctrines. Neo-Platonism in Alexandria elaborated the dualist concept of mind and body which subsequently permeated European philosophy. In the 18th century, a Cambridge school of Platonists helped to perpetuate the doctrine that the human body is a more or less inert instrument of a spiritual force. Exerting very considerable influence on Newton [1, 2, 8] concerning the nature of space and time, Henry More and other Cambridge Platonists were solidly behind Newton in his emphasis on the absolute inertia of 'inanimate brute matter'. Such a view of matter displayed the human body as the passive instrument of a spiritual force, animating the body and responsible for moral and religious ideas. Modern physiology has discarded this dualist concept of mind and body as an intolerable obstruction to scientific progress. Yet this concept remains in other spheres of 'higher education' as a prized bone of philosophical contention. When the bone is finally buried, dialectic materialism will cease to deal with purely philosophical questions. The future of modern materialism lies not in the musty past of metaphysics, but in the ever widening scope of the natural and social sciences, and in the patient groping of mankind for a new world outlook.

For Sir Oliver Lodge, 'Not only the heavens, but the earth; not only the flowers, mountains, sunsets, but every pebble, every grain of dust, the beautiful structure of every atom, proclaim the glory of the Being who planned and understood it all' [4]. The teleology expressed here is found in other passages of *Science and Human Progress*. For example: 'Everything is arranged for some great and far-seen Purpose, towards the

furtherance of which each in his day and generation is privileged to help' (p. 58). This theological view of 'divine purpose', expressed openly under the title *Science and Human Progress*, indicates the undercurrent of religious belief which exists in scientific circles. The truth is that Lodge has misnamed his work, for the ideas expressed in it mark no progress, but a retrogression from scientific achievements. Laplace, the great astronomer of the eighteenth century, when asked by Napoleon where was the place of God in his theory of the universe, replied: 'I have no need of that hypothesis'. Lodge, it seems, has brought back God, not merely as a hypothesis, but as the only reality, for he says: 'In moments of insight, we feel that . . . the whole universe is a manifestation of the Godhead; that it really is, as Goethe poetically expressed it, the living garment of God!' (pp. 39, 40).

In common with Eddington and Whitehead, Oliver Lodge advocates 'faith' as the guiding principle of investigators. The following passage exemplifies the poisonous growth of mysticism which is spreading through British 'scientific' literature: 'We must be limited neither by our sensory faculties nor by our reasoning faculties . . . there is a region of mystery even in the most ordinary commonplace action of daily life; still more is there a region of mystery in the beyond. . . . We can only patiently grope with such faculties as we possess, and with such aid as has been vouchsafed to us, and thus gain humble access to the region of faith' (p. 82).

So we 'must not be limited by our sensory faculties nor by our reasoning faculties'! We are at liberty to 'soar in our imagination' above them! Anything, then, *may* be admitted as true—pigs may have wings; the air may be regarded as full of unseen witches on broomsticks and other figures, etc. We are not limited by our sensory faculties, so each to his fancy as to what exists 'in the beyond'! For information about such regions of mystery we must rely on 'intuition', or 'imagination'. This is the sort of thing that Lodge's mysticism leads to. It is a logical conclusion of his dualism, which supposes mind to be capable of existing independently of matter. Mind is therefore able to roam free and take arbitrary forms. Thus, there may be something beyond the world of perception *independent* of matter. This brings us to fideism, which permits the introduction of all kinds of religious and mystical fantasies. Having gained 'humble access to the region of faith', Lodge is at liberty to portray the world at his own sweet will, disregarding the protests of those

who are unfortunate enough to be limited by their sensory faculties.

Compare this spiritualistic rubbish with Freud's work, *The Future of an Illusion*, which contains the following passages contrasting scientific knowledge with the beliefs of 'insight' or 'intuition': 'The riddles of the universe only reveal themselves slowly to our inquiry, to many questions science can as yet give no answer; but *scientific work is our only way to the knowledge of external reality*'. Again, '*it is merely illusion to expect anything from intuition or trance*'. They can give us but particulars, which are difficult to interpret, about our mental life, never information about the questions that are so lightly answered by the doctrines of religion' (p. 55).

5 THE UNIVERSE AND 'GOD'

Lodge's fantastic idea of the universe as part of the 'garment of God' closely resembles Sir James Jeans' mystical conception of the universe. In his *Astronomy and Cosmogony* Jeans ends with these few words of philosophy: 'What, if any, is our relation to the remote nebulae, for surely there must be more direct contact than that light can travel between them and us in a hundred million years? Do their colossal uncomprehending masses come nearer to representing the main ultimate reality of the universe, or do we? Are we merely part of the same picture as they, or is it possible that we are part of the artist? Are they perchance only a dream, while we are brain cells in the mind of the dreamer? . . .' [5].

It is true that Jeans adds: 'It is not for the cosmogonist to attempt to suggest answers to these wide questions', but the very fact that he concludes with this mystical idea dug up from last century marks him as belonging to the idealist camp. He further allies himself with the idealists by saying of 'the cosmogonist' (such as himself). 'His critics may allege that *what he sees most clearly is only a creation of his imagination, and he is only too conscious that this may be so*'. So the universe 'may' exist only in the mind of 'the cosmogonist'! Matter—of the stars and planets, including the earth—'may' be an illusion; reality 'may' only be mental in character. The world 'may' be my idea, or rather the idea of 'the cosmogonist'! It is obvious that we have found in Sir James Jeans another follower of Bishop Berkeley, if a somewhat diffident one.

The idea that 'we are brain-cells in the mind of the dreamer' (or God), is paralleled in Jeans's book *The Universe Around Us*, in a discussion on the creation of the universe which concludes: 'On this view, discussing the creation of the universe in terms of time and space is like trying to discover the artist and the act of painting, by going to the edge of the picture. *This brings us very near to those philosophical systems which regard the universe as a thought in the mind of the Creator*, thereby reducing all discussion of material creation to futility' [6]. Jeans adds that this point of view (as well as certain others) is 'impregnable'.

It is impossible to take seriously the suggestion that the universe is 'a thought in the mind of the "Creator".' Neglecting the mountain of absurdities and contradictions which are involved in the conception of a 'Creator', the question may be asked: if the universe is 'a thought in the mind of the Creator', then must not the 'Creator' have a brain to think with? Apparently Jeans thinks so, for in *Astronomy and Cosmogony* he mentioned the possibility that 'we are brain-cells in the mind of the dreamer' (p. 422). Thus, the universe may be a huge body, or brain, of which we are 'brain-cells'! This idea was suggested last century, and was subjected to criticism by the scientists W. K. Clifford and Du Bois Reymond. While Clifford was an idealist and Du Bois Reymond an agnostic, neither could swallow this fantastic story. Clifford wrote in the *Fortnightly Review* (Dec 1874) as follows:—

'Can we regard the universe, or that part of it which immediately surrounds us, as a vast brain, and therefore the reality which underlies it as a conscious mind? This question has been considered by the great naturalist Du Bois Reymond, and has received from him that negative answer which I think we also must give . . . if some vast brain existed somewhere in space, being invisible because not self-luminous, then, according to the laws of matter at present known to us, it could affect the solar system only by its weight'.

Apart from speculative criticisms, the idea that Jeans repeats is a religious one of the anthropomorphic variety, that is, it attributes human form to God. Obviously, 'dreamer' and 'Creator' are rather more high-sounding names for God. In tentatively attributing a brain to God, Jeans is falling in line with the best clerical tradition. A brain requires a skull, and a skull requires a skeleton, appropriately clothed with flesh. Thus, in suggesting the possibility of the universe forming part

of the brain of a 'dreamer' (with ourselves as 'brain-cells') Jeans is presenting God in human, or semi-human form, much in the manner of the Hebrew prophets. In the light of present day science this can only be described as twaddle, and was recognized as such by Haeckel at the close of last century. Ernst Haeckel was a great scientist who produced from his extensive knowledge many sound arguments for materialism, 'thereby enraging idealist supporters of the Church. Describing these opponents in his *Riddle of the Universe* (in terms very fitting for some of our British mystics) he says:—

'Our modern education, the outcome of our great advance in knowledge, has a claim on every department of public and private life; it would see humanity raised, by the instrumentality of reason, to that higher grade of culture, and, consequently, to that better path towards happiness, which has been opened out to us by the progress of modern science. That aim, however, is vigorously opposed by the influential parties who would detain the mind in the exploded views of the Middle Ages, with regard to the most important problems of life; *they linger in the fold of traditional dogma, and would have reason prostrate itself before their "higher revelation"* [7].

Haeckel goes on to analyse and classify the various religious ideas concerning humanity and God. One group of ideas he distinguishes as anthropomorphic, and describes it as follows:—

'The *anthropomorphic* dogma . . . likens the creation and control of the world by God to the artificial creation of a skilful engineer or mechanic, and the administration of a wise ruler. God, as creator, sustainer, and ruler of the world, is thus represented after a purely human fashion in his thought and work. Hence it follows, in turn, that man is god-like. God made man to His own image and likeness. The older, naïve mythology is pure "homotheism", attributing human shape, flesh and blood to the gods. It is more intelligible than the modern mystic theosophy that adores a personal God as an invisible—properly speaking, gaseous—being, yet makes him think, speak, and act in human fashion; it gives us the paradoxical picture of a "gaseous vertebrate" ' [8].

It is seen, therefore, that Sir James Jeans is able to produce no better philosophical accompaniment of his astronomical researches than a fantastic religious doctrine which was given its deathblow by the advance of scientific knowledge in the last century. As for Jeans' suggestion that we are 'brain-cells' of

a 'dreamer', it is plain that either he himself is dreaming, or else has never examined actual brain-cells, which are microscopic particles of undivided protoplasm connected by means of numerous branches (axons and dendrites), and nourished by fine capillary blood-vessels. After such a suggestion it would not be surprising to find Jeans calling our roads and railway tracks the branching processes of the 'dreamer's' brain, with railway tunnels for blood-vessels! It is indeed amazing to find an authority in one branch of science (astronomy) suggesting an idea which contradicts every principle of physiology, another branch of science. It is just as if an eminent physiologist mentioned the possibility of the moon being made of green cheese, or the stars being the pseudopods of some gigantic amœba! This kind of thing may be expected from a Sunday School religious teacher, but when it comes from an astronomer readers may well wonder at the ways of eminent scientists who dabble in questions of philosophy and religion.

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Chapter V

THE IDEALISM OF 'BIOLOGY'

1. SUBJECTIVE IDEALISM AND THE CRITERION OF PRACTICE

A GIFFORD lecture room is a favourite stamping ground for scientists displaying their taste in philosophy. The Gifford lectures of the late Professor J. S. Haldane, published under the title *The Sciences and Philosophy*, form a perfect illustration of the metaphysical complaint that so often afflicts men of science when their social eminence is higher than their scientific outlook. In practice, J. S. Haldane was a great physiologist who sought material causes for the behaviour of living organisms. But in his metaphysical departures from rational thought he was a vitalist, a Berkeleian idealist, and a believer in God; expressions of these three characteristics are mixed together in *The Sciences and Philosophy* and given the label of 'organic unity'. The usual collection of words with special subjective meanings attached by the author is also found. Haldane's 'interest', for the development of which the sciences are 'practical tools', his 'spiritual values' which make up the 'real world', and are said to be the manifestation of God; his 'experience', which includes emotional feelings—all these terms serve to subordinate scientific knowledge to religion and its ally subjective idealism.

There is no difficulty in displaying Haldane's alignment with Berkeley's subjective idealism, for he says plainly: '*There is no such thing as a physical world existing apart from consciousness*'[1]. This is pure solipsism, for it reduces the world to a solitary philosophizing individual. It is equivalent to saying 'The world is my idea'. Such an absurdity is seldom seen in conspicuous isolation, and Haldane, who plainly takes up solipsism, nevertheless tries to shield it by putting immediately afterwards a scientific truth, namely, the non-existence of absolute motion and time. It is better to give the quotation again in full:—

'There is no such thing as a physical world existing apart from consciousness; no such thing as absolute space or time, or space-time, or absolute mass, motion, or energy'. Thus there is mixed up with the philosophical absurdity scientific ideas

borrowed from relativity physics, which are quite irrelevant. If Einstein's theory of relativity is correct, then there is no *absolute* space or time or motion, but this, of course, does not deny the absolute truth that there is a physical world apart from consciousness, consisting of matter in motion.

In his next words Haldane reveals another linkage with idealism, this time of the Machian brand: '*physical science does not really set out to interpret reality, but only to discover and make use of such a provisional conception as can be used for certain limited practical purposes*' [2]

Having denied the reality of the physical world apart from consciousness, Haldane follows Mach, Poincaré and Pearson, who formulated the object of science as 'economy of thought', and a *description* 'in the interest of the individual'. The Machian idealists all follow the same road: the physical world is reduced to 'sensations', or consciousness, and then science becomes a mere 'economy', or a 'description', or a provisional conception 'for practical purposes'.

This raises the question of the application of the criterion of practice in science and philosophy. Haldane and other Machian idealists interpret the criterion of practice in a subjective sense, depending on man, and applied to his needs. The basis of knowledge is neglected, and only practical methods are considered, that is, practice is dissociated from epistemology, the theory of knowledge. Practice is applied as a test of the 'use' of scientific conceptions, while all the time a philosophy of subjective idealism is held regarding the world. The Machian idealists, interpreting the criterion of practice in a subjective sense, deny that practice is adequate to serve as a criterion of objective truth.

This is directly opposed to the materialist view, which holds that the approximate correctness of our ideas about objective reality is proved by the success in practice of the application of those ideas. Thus for materialists the criterion of practice is bound up with the theory of knowledge. Materialism holds that scientific theory reflects objective reality of the physical world and that this is proved by the approximate coincidence in practice of scientific theory with the facts of objective reality. It holds that the practical application of a theory determines (within limits) its truth in regard to the nature of the physical world. The criterion of practice is thus an essential part of the theory of knowledge.

The difference between materialists and idealists such as Mach as regards the criterion of practice is described by Lenin as follows:—

‘It is a sham professorial idealism when the criterion of practice, which makes a distinction between illusion and actuality, is taken by Mach out of the realm of science, out of the theory of knowledge. Human practice proves the correctness of the materialist theory of knowledge, said Marx and Engels, declaring as scholastic and “philosophical legerdemain” all attempts to solve fundamental epistemological questions which ignore practice. For Mach practice is one thing and the theory of knowledge another. “Cognition”, says Mach in his last work, *Erkenntnis und Irrtum*, “is a biologically useful mental experience. Only success can separate knowledge from error (p. 116). . . . Understanding is a physical working hypothesis”. . . . With Mach, such assumptions stand side by side with his idealist theory of knowledge, but do not preponderantly determine the choice of a fundamental tendency or theory in epistemology. Knowledge may be biologically useful, useful in human practice, in the preservation of the species, but *it is useful only when it reflects an objective truth, independent of man. For a materialist the success of human practice proves the correspondence of our representations to the objective nature of the things we perceive. For a solipsist, “success” is restricted to what is needed only in practice and can be dissevered from the theory of knowledge*’ [3].

2. HOW IDEALISM SUPPORTS RELIGION

From idealism to anti-intellectualism and religion is but a short step. Haldane makes it easier by an ambiguous use of the word ‘experience’, which is used to cover both the idealist and materialist standpoints, and thus confuses the distinction between them. This is an old evasion, employed long ago by Machians, for example by Avenarius. Science is regarded as part of ‘experience’, which is also made to include emotional feelings. Haldane presents this view as follows: ‘experience includes: . . . the fact that this physical world is perceived, and that with the perception of it we perceive ourselves and numerous living and sentient beings, *as well as endless emotional and other experiences* which cannot be interpreted as pertaining directly to physical objects’ [4]. Haldane later on says that

language and the sciences are abstractions, to which we can assign 'their proper and indispensable place in our experience' [5]. Thus both scientific observation and emotional feelings are included under the word 'experience'.

Once this meaning is attached to 'experience' it is an easy matter to extend a toleration or welcome to religious teachers, who have also had 'experiences'. The reconciliation of science and religion is further arranged for by the already mentioned interpretation of scientific theories as merely descriptions or recipes 'for practical purposes'. If the sciences are only 'practical tools' as Haldane says (p. 256), then the practical recipes and formulæ of religion cannot be rejected as untrue, for they also arise out of 'experience'. While science then has (only) a practical significance in one domain of human activity, religion has a no less real significance in another domain. This was the conclusion drawn by the French fideist Le Roy from the writings of Henri Poincaré, the French Machian. Poincaré, in *The Value of Science*, repudiated the fideist conclusions of Le Roy, but Haldane does not reject religious beliefs built up on the basis of a philosophy. On the contrary, he combines in one person the philosophical idealist and the fideist of religious beliefs, with the help of an ambiguous use of the word 'experience', which is used to denote subjective emotion as well as contact with aspects of the physical world.

Haldane paves the way for a confession of religious belief by saying: 'the function of philosophy is to enable us to frame as consistent as possible a working conception, not merely of part, but of the whole of our experience' [6]. Having put science and philosophy on a subjective basis of 'experience', Haldane ventures to present God as a reality: 'The conclusion to which the argument of this course of lectures will lead up to is that our universe, under whatever guise of constituent self-existent things or personalities it may for the moment appear to us, can be nothing else but the manifestation of one Spiritual Reality or one God. It is thus what may be called spiritual realism that this course of lectures will represent' [7].

'Spiritual realism' is a euphonious phrase. Its significance is clear from the previous words—evidently Professor Haldane is telling us that God is real. His arguments for this assumption are based partly on an ambiguous use of the word 'experience', which thus covers subjective emotions as well as relations with objects of the physical world. However, the chief philosophical

prop to religion is the denial of the independent reality of the physical world. Haldane shows this very plainly by saying: *'In actual fact religion must sooner or later appear to us as nothing but an illusion and mockery if once we take the initial step . . . that the visible world around us is in reality a physical world. ∴'* [8]. Haldane is quite correct—subjective idealism is a philosophical basis of religion.

Those who assert that the physical world does not exist apart from consciousness must disregard the fundamental discoveries of modern science. All the evidence accumulated regarding the evolution of the earth, as well as of living things, goes to prove that the physical world existed for ages before man, with his brain and consciousness, came upon the scene. The science of astronomy tells us that for a long time during the development of the earth conditions were such as to render life impossible. The science of geology teaches that in the earliest epochs of the earth there were no reptiles, birds or mammals. The theory of evolution, based on a host of facts, and backed by the great mass of scientific opinion, holds that at one stage of the development of living things the most highly developed nervous system consisted only of one or two nerve cells, and that before then there was no differentiated nervous system at all. As we know that consciousness depends on a highly differentiated nervous system, consisting of a great many specialized nerve cells, it is obvious that consciousness appeared only at a comparatively late period of the world's history. In the face of this evidence it is sheer absurdity to talk about the physical world not existing apart from consciousness, when the facts of science show that for millions of years the physical world existed and developed without life at all, while for ages after that life was associated only with matter incapable of producing consciousness.

Professor Haldane was a scientist in the field of biology. Why was it that he made the absurd statement that there is no physical world apart from consciousness? The reason is that in questions of philosophy such scientists are unable to preserve their scientific views, *because these lead inevitably to materialism*. The modern scientists who set up systems of philosophy are nearly always idealists, who wish to place mind prior to matter. This is directly opposed to the materialist view, which regards mind as a derivative of organized matter. Materialists place mind secondary to matter, because they consider that mind only came into existence when the material world reached a

certain stage of development, and that mind is a function of the brain. Idealists, on the other hand, place mind in the primary position, and say that matter is dependent on, and secondary to, mind. This difference is the essential cleavage between materialism and idealism. It is the question of whether the physical world exists apart from consciousness or not; whether matter is primary, or mind. Professor Haldane, who called his philosophy 'spiritual realism', was obviously an idealist, from his own statement of the dependence of the physical world on consciousness. For this reason he had to desert his scientific knowledge when discussing questions of philosophy, because the facts of science—of astronomy, geology, biology, etc.—support unmistakably the arguments of materialism.

It may be asked why certain professors make such efforts to protect idealism from the attacks of materialism. *The reason is that idealism tends to preserve the influence of religion and therefore of Church and State—in fact, the existence of the present system of society.* Haldane practically tells us as much in the following words:—

'It seems to me that just in proportion as we classify religious beliefs from materialism, without at the same time dimming our perceptions of ultimate spiritual reality, we are strengthening religion. As soon as we see that the universe as interpreted physically or biologically is only an ideal construction, we can rid religious belief from its materialism, so that the spiritual reality with which religion is concerned stands out far more clearly. . . . If, however, we only clear away the bad science in religious beliefs, without at the same time realizing the reality of what is spiritual and its practical significance, there is apparently no religion left, and spiritual values become dim. . . .

'If we merely lop away the apparent inconsistencies between religious beliefs and the physical or biological interpretations of reality, leaving these interpretations as if they represented reality, no basis at all is left for real religious belief, and religion becomes a mere subjective make-believe When the illusion of religious belief finally died out, we should apparently be faced by a state of society in which honesty, diligence, charity and patriotism would have to be enforced by the feeble weapons of compulsion or individual self-interest. *Such a society would be wholly unstable and would go down at the first encounter with an intelligent society inspired by religious beliefs*' (pp. 283, 284) [9].

It is clear from these words that Haldane understood the significance of his task as a philosopher: to get rid of materialism so that religion may flourish for the good of 'society', which is capitalist society. . . .

3. PROFESSOR J. S. HALDANE'S 'BIOLOGICAL INTERPRETATION' OF NATURE

The philosophical structure which Professor Haldane builds has for one of its supports a statement made last century by Claude Bernard, the famous physiologist, who said: 'All the vital mechanisms, varied as they are, have only one object, that of preserving constant the conditions of life in the internal environment'. This of course is making a philosophy out of a single scientific fact, namely the relative constancy of certain physical conditions of an organism. The statement is quite misleading in so far as it makes an *end* out of what is in reality a *part* of life. Claude Bernard's statement implies that there is a co-ordination in protoplasmic activity directed towards a certain end. It is this conception of co-ordination which Haldane takes and exalts to the pinnacle of an idealist philosophy to which the term 'biological interpretation' is applied. All natural phenomena are held to be the manifestations of a vague, universal, non-material 'life', and so Haldane joins the ranks of the vitalists, his 'life' being analogous to Johannes Muller's 'organizing principle.'

This 'biological explanation' is, we learn, 'not causal explanation'. Haldane here joins those who regard science as merely a 'description' of phenomena. He denies the existence of cause and effect in the course of his 'biological' interpretation of nature. Haldane's 'life' thus becomes a mystical force not subject to laws of cause and effect.

Haldane proceeds towards further mysticism by extending his 'biological interpretation' to cover the inorganic world! He says: 'Just as within the bodies of living organisms we find scope for the application of both a biological and physical interpretation, so do we in their environment. We cannot consistently express in physical terms the observations which we interpret biologically. Nor do we see any way clear to expressing biologically the details which we interpret physically. But in view of the irreducibility of biological to physical interpretation,

the only possibility of reaching consistency as regards interpretation of the two sets of observations would be by *extending the biological interpretation to the observations interpreted physically. It is only, however, by an act of faith that we can do so. We cannot actually perceive life in the details of what we at the same time interpret as an inorganic world* [10].

This astounding view would be incomprehensible did we not know that it is an idealist who is writing, to whom all things are possible by means of faith. Haldane appears to be suggesting that the conceptions of biology should be extended to the physical world of inorganic matter. That is, *all* objects, inorganic as well as organic, should be considered scientifically as if they were alive! Haldane's 'biological interpretation' invades other fields of science, whose workers were hitherto under the impression that what they were studying was not alive. The physicist studying the pendulum and the chemist studying the crystal are now told by Professor Haldane that what they are studying is capable of being interpreted as he himself 'interprets' living protoplasm, that is, 'biologically'! Thus: 'The biological interpretation is, in fact, different from the physical interpretation, *but applies over the same phenomena*' [11].

The reader will be wondering what Professor Haldane understands by life—if he proposes to extend the science of living things to cover non-living physical objects! It is all quite simple! With a benign reproof he censures those who believe life to be something which has evolved in the course of time from inorganic matter. Life, the Professor tells us, never had any beginning in time! He says: 'Those who may still have a lingering affection for a mechanistic conception of life, *or who imagine that life must be something which had a beginning in time*, would do well to ponder further over the nature of hereditary transmission' [12]. The question is naturally asked: if life had no beginning in time, then what is its relation to the physical world, which is considered by science to have been at one time a mass of incandescent gas? Haldane replies (if it can be called a reply) as follows: '*I wish to emphasize as strongly as I can that the belief in a merely physical world surrounding us has no basis. Our environment is not something indifferent to our lives, but belongs to them.* Surrounding Nature is not an influence outside our lives, but within them' [13].

The secret is out! The physical world does not exist apart from 'our lives', and therefore life had no beginning in time in

the physical world. Nature is within 'our lives', and, of course, 'our lives' are not our bodies, for in that case nature—our environment—would be inside our bodies! The physical world, it is said, does not exist apart from our lives—nor, therefore, apart from our sensations and mind. It is quite clear that Haldane is saying that mind is the primary reality, and that the physical world does not exist apart from mind. Thus the preceding assertions simply amount to this—that Professor Haldane is an idealist.

Let us now examine further Professor Haldane's treatment of the co-ordination of living organisms. He says, on the one hand, that the co-ordination apparent in the phenomena of living organisms 'is part of their very nature'. This is correct, for the co-ordination between different parts of the human body, for example, lungs, heart, kidneys, etc., is part of the very nature of those organs and of the body as a whole. The nervous system plays a leading role in the co-ordination of different parts of the body, but co-ordination is inherent in the living bodily structure, and is developed in the reaction of the individual to its environment. Furthermore, as organisms have acted upon their environment their powers of co-ordination have developed. Man, with highly developed powers of co-ordination, for example, as can be seen in the functioning of the hand, has acquired these powers in the course of his ancient social struggle with nature.

Haldane now proceeds to criticize the mechanistic interpretation of living things, which seeks in physics and chemistry a complete understanding of the phenomena of life. He says: 'In the case of what we call organic phenomena we can see from the outset that mechanical interpretations are impossible'. Also: '*It may be that there are still some physiologists who believe that the progress of physiology is bringing us nearer to a physico-chemical conception of life. But if there are, I can only say that their intellectual vision seems to me to be very defective*' [14]. Again: 'We can investigate one by one the various conditions on which the maintenance or development of normal structure and composition depends, and there seems to be no limit to the complexity of these conditions from the physico-chemical standpoint. But of their specific co-ordination in maintaining and originating normal structure *we can find no trace of a physico-chemical explanation*, so that each discovery makes the attainment of such explanation more remote' [15].

In replying to these statements we must bear in mind the relative distinction between living and non-living matter. A common error is the belief that biology is simply a part of physics and chemistry. The incorrect view is held that biological phenomena are reducible to 'physico-chemical' or to 'physical' phenomena, i.e. to processes identical with those of non-living matter. According to this mechanistic view, the qualitative difference in biological phenomena is disregarded, and the distinction between living and non-living processes is obliterated. This error is dealt with by B. Zavdovsky in his paper "The 'Physical' and the 'Biological' in the Process of Organic Evolution", of which the following is an extract :—

'Biological phenomena, historically connected with physical phenomena in inorganic nature, are none the less not only not reducible to physico-chemical or mechanical laws, but within their own limits as biological processes display varied and qualitatively distinct laws. Thereby biological laws do not in the least lose their material quality and cognizability, requiring only in each case methods of research appropriate to the phenomena studied.

'The necessary consequence of the above is a conclusion as to the dialectical development of matter by leaps, bound up with qualitative revolutionary changes as a result of the accumulation of quantitative changes, and the idea of the *relative* autonomy of the biological process, advancing not only in circumstances of interaction with the physical conditions of its surroundings, but also as a result of the development of the internal contradictions latent in the biological system itself. By this means are overcome the over-simplified mechanistic attempts to conceive of the biological process of development as the result of only the physical influences of external surroundings, or of similar physical and physico-chemical processes inside the organism itself or its genes, by which means, it is alleged, it is possible to explain the most complex and qualitatively peculiar phenomena of mutatory variation, and thereby the whole process of formation of species. At the same time this standpoint also overcomes the metaphysical opposition of the biological to the physical, as an absolutely autonomous and independent principle, to the extent this biological is considered in its indissoluble historical connection with physical phenomena (as a higher form of motion, originating out of lower inorganic forms of motion of matter), and also its dynamic connection (metabolism).

'At the same time dialectical methodology by no means eliminates the role of the external and physical in the process of organic evolution, requiring only a sharp definition of these conceptions in each case, and the recognition of the multiformity of all those forms of connection which exist between organisms and their external surroundings, between the "biological" and the "physical". Thus the physical constitutes the necessary *condition* in the framework of which the biological process takes place, but at the same time it enters as a necessary aspect into the biological process as such. Furthermore, it may be the direct stimulus of mutatory variations in the germplasm, thus simultaneously being both external and internal in relation to the "biological". Finally, it may serve as the controlling factor which, in the process of natural selection, determines the very course of evolutionary process, and therefore acts as the creator of biological forms. In this way the "external" is composed not only of the physical conditions of the external surroundings, but also of the biological encirclement by a milieu of other organisms, and also—in the case of the evolution of man—the social-economic relations prevailing within human society' [16].

In contrast to the mechanistic view (that of the old materialists) dialectic materialism teaches that living matter is subject to natural laws of a special kind, within which the laws of physics and chemistry have a *limited* application. To take an analogy from physics, it has been found that the Newtonian system of laws has a validity which is limited to a certain field of application. Beyond that field facts are encountered which are explicable only on the basis of relativity physics. In biology, the laws of physics and chemistry have been applied to the phenomena observed with very considerable results. However, there are facts which strongly indicate the necessity for the formulation of that wider system of laws which must apply to living matter in particular. It is especially in cellular and intercellular processes that the old mechanistic theories are failing to cover the facts observed. As biologists adopt the principles and methods of dialectic materialism in their work, they will elaborate those new theories and laws of which the necessity is now becoming apparent. Meanwhile vitalists and idealists ridicule the old mechanistic materialism for its limitations and failures, and attempt to replace materialism with their own mystical interpretations.

Haldane's 'biological' interpretation attributes natural phenomena to the manifestations of a non-material 'life', which had no beginning in time and which is not subject to laws of cause and effect! By means of an 'act of faith' Haldane extends this interpretation to inanimate nature! By a judicious mingling of vitalism and idealism he makes it appear that he is substituting a new, natural explanation in place of mechanistic materialism. In reality, however, he is substituting a *supernatural* point of view, in which philosophical idealism provides the cover for vitalism. Having denied the existence of a physical world independent of consciousness, Haldane attempts to avoid being convicted of vitalism by pointing out that his 'life' is not something acting on organic matter as an outside agency (in the manner of the 'vital force' of other vitalists). Obviously, Haldane has not discarded the supernatural 'force' of vitalism, but has merely discarded the belief in an independently existing physical world which other vitalists have held. With matter out of the way, any fantasy may be classed as 'natural', even a 'life' with no beginning in time, and not subject to laws of cause and effect.

Although science is only beginning to explore living processes and the nature of their co-ordination, already certain substances are known which, when acting in the human body, can produce definitely co-ordinated effects. While the mode of action of these substances within the body is but little understood, the fact that they have been distinguished at all is highly significant and emphasizes the futility for science of Professor Haldane's attitude towards the co-ordination of living processes. Take, for example, the action of the chemical substance *adrenalin*, which is found in the animal body, and has also been made synthetically outside the body. It is secreted by a special gland, and is discharged into the blood stream under certain conditions, e.g. those giving rise to mental disturbances of excitement or fright. *It is essential for the co-ordination of the functions of different organs of the body*, and is thus of use to an animal in its reactions to special circumstances. 'Through the splanchnic nerves, a discharge of adrenalin can be excited by many general conditions, such as . . . mental disturbances such as excitement or fright. Such a discharge is an important element in the adaptation to environmental stress, and enables the animal to react for the preservation of its life either by offence or by flight'. (Starling's 'Principles of Human Physiology', 5th. ed. 1930, p. 955.)

The action of adrenalin in co-ordinating different bodily functions includes the following elements: rise of blood pressure, quickening and strengthening of the heart-beat, increase of sugar in the blood, dilatation of the pupil, and erection of the hair of the body. There is a greater flow of blood to the muscles, central nervous system and heart, and a greater amount of sugar available for the production of energy. These co-ordinated effects follow an experimental injection of adrenalin into the blood circulation of an animal, and the evidence points to these and other regulated actions occurring as a result of special circumstances in the normal life of an animal, e.g. dangers which arouse the signs of anger or alarm.

Master gland of the endocrine system is the pituitary body situated at the base of the brain, to which it is connected by fibres from the hypothalamus. Receiving other nerve fibres from the superior cervical ganglion, the pituitary body is the main intermediary between the nervous system and the system of endocrine glands whose secretions exercise chemical control over the various tissues of the human body.

The pituitary gland secretes into the blood-stream a chemical substance which regulates tissue growth; another which controls the activity of the thyroid gland—the regulator of the rate of chemical turnover of the tissues; another hormone controlling the activity of the adrenal gland, and still another regulating sex gland function. Other co-ordinating controls carried out by the pituitary cover the capacity of the kidney to prevent sugar leaking out into the urine, the maintenance of the normal blood pressure, and the degree of contraction of the uterine muscle. These regulating activities of the pituitary gland, performed through secretion into the blood-stream of chemical compounds which affect distant organs in a specific manner, are themselves regulated by the sympathetic nervous system, the main co-ordinator of involuntary bodily functions.

If pituitary activity becomes sufficiently diminished or increased in one way or another, signs of disease or abnormality arise. Too much pituitary growth hormone in early life makes a gigantic individual who may be over seven feet high. Too little pituitary growth hormone in early life gives the Lorain type of dwarf whose sexual functions may be below normal.

Of all gland disturbances, the most dramatic is the pituitary catastrophe that produces Simmonds' disease. Deprived of some obscure pituitary control, an individual's life-span forthwith

becomes fantastically shortened. Within a few months, a young man or woman with this pituitary disorder becomes physically and mentally aged, with dry wrinkled skin and weak wasted muscles. Within a few months, hair and teeth fall out, sex glands degenerate and mental functions deteriorate. What would normally take place in twenty or thirty years of further life occurs during the same number of weeks in cases of Simmonds' disease. Dramatically, a lack of proper pituitary control of the body results in premature and rapidly developing senile decay. No more striking illustration of the power of a gland to co-ordinate bodily functions at a particular tempo can be imagined. In the pituitary gland resides a biological apparatus for controlling in a co-ordinated manner the rise and decline of all bodily activities.

Equally definite and striking is tissue control by a chemical means in the development of an embryo. An embryo's nervous system, which in the adult animal becomes the chief means of co-ordinating all parts of the body, grows out of the dorsal part of the developing egg. By means of a folding process, this part of the fertilized egg forms a cell-lined tube—the neural tube, from which is elaborated later the brain and spinal cord. The initial formation of the neural tube is controlled chemically by a particular group of cells at the entrance to the primitive cavity of the developing egg. If this group of cells forming the dorsal lip of the blastopore is interfered with experimentally, the embryo fails to form a neural tube and does not develop to normal maturity. Losing its own biological organizer, the embryo displays an inability to produce the beginnings of a nervous system.

Thanks to revealing experiments by J. Holtfreter (1933), J. Needham, C. H. Waddington, H. Spemann and others, we now know that a non-living substance can act as an organizer for the embryonic differentiation of a nervous system. If a small piece of liver or muscle or other animal tissue is boiled and then implanted among the undifferentiated cells of a fertilised egg, the latter proceeds to develop the beginnings of a nervous system. A piece of boiled mouse heart placed among the living cells of a human embryo has actually induced the formation of a secondary or 'extra' brain. (Joseph Needham, *Biochemistry and Morphogenesis*, 1942, p. 172.)

What was once assumed to be the work of an omnipotent deity has now been traced to physico-chemical agencies. A

fertilised egg, whether of frog, chick or man, grows into a normal embryo through a certain cell response to the presence of particular chemical compounds. An extract of seven day old chick embryo, or an extract of liver or brain, will also mould the development of a developing egg so as to produce the beginnings of a nervous system, and so will certain chemical compounds such as cephalin, steroids and oleic acid. Applied experimentally to a growing fertilised egg, such compounds initiate the morphological changes which proceed as a rule from the activity of a particular group of organizer cells in the dorsal lip of the blastopore.

In its natural state, an embryo is regularly spurred to further stages of development by the progressive 'unmasking' of specifically active chemical compounds in various parts of its anatomy. Embryonic growth, beginning with the morphological differentiation of a neural tube, is thus controlled and co-ordinated chemically by a spatio-temporal pattern of chemical stimuli, to which the embryonic tissue responds by growing, shaping and differentiating itself in the usual manner. The most perfect embryonic development proceeds from the production of specific chemical compounds (evocators) by groups of living cells acting as organizers of biological form and function. When these compounds act out of order, breaking the normal spatio-temporal pattern of chemical stimulation, embryonic growth is abnormal and a monster may be born. Only if the physico-chemical formula of gene-directed evocators is correct do the cells of the embryo work out the normal structure of a mature individual.

These examples serve to show how science has already taken hold of the problem of the co-ordination of various bodily processes in the higher animals. The many facts known about the control of the nervous system over different parts of the body form another advance in this direction. As biologists grasp the full content of dialectic materialism a rapid advance will no doubt take place especially in the fields of intracellular and intercellular processes, which may altogether transform our present ideas. The elaboration of new laws of biology constitutes a task for planned collaboration in science on a scale far greater than exists in this country at present. Only when the proletariat has transformed society will this planned collaboration be fully realized. Meanwhile we have its antithesis—in the writings of Professor Haldane and other idealist philosophers!

In his later book, *Materialism*, Haldane maintains his idealist position, from which he continues to ridicule the mechanists, apparently unaware of the existence of modern (dialectic) materialism. His arguments reach the conclusion 'that the universe of our experience is spiritual and personal, and cannot by any possibility be regarded, except for very limited practical purposes, as a mere physical universe' (p. 213). Combined with idealism is a species of pantheism : 'God is present in all that appears to us' (p. 138).

Why living matter behaves as it does is no longer a question of abstract philosophical speculation. New methods of investigation and new instruments are revealing more of the peculiar physico-chemical conditions which make possible the specific behaviour of living organisms. The complex processes of living cells are seen to depend upon colloidal systems in which carbon compounds are rendered extraordinarily plastic and renewable. By means of X-ray photography, the ultracentrifuge, the electron microscope, electrophoresis and various chemical methods of investigation, biologists are unravelling the intricate nature of protein, which under certain circumstances forms the dynamic framework of living cells.

A necessary condition of cell life is a flow of water which bathes the surfaces of the cell's colloidal particles and serves the respiratory and fermentative processes which provide the energy of life. Cell life, upon which the bodily, mental, and social life of mankind is based, is a dynamic display of interlocking physico-chemical processes, in which water plays the part of a solvent, sluice and chemical catalyst. The fluid changing nature of a living cell has been described by Charles Sherrington, world famous neurologist, as 'a scene of energy-cycles, suites of oxidation and reduction, concatenated ferment actions. It is like a magic hive the walls of whose chambered spongework are shifting veils of ordered molecules, and rend and renew as operations rise and cease. A world of surfaces and streams' [17].

How sharp a contrast is the stable and comparatively static structure of an inanimate solid body such as a crystal of iron, or salt, or sugar! Here there is no such kaleidoscopic scene as that described by Sherrington. In the quiet order of a crystal there is none of the ceaseless metabolic change characteristic of living matter. And until recently, biologists could point to no type of structure bridging the gap between inanimate solid bodies and the living cell with its ceaseless metabolic activity.

Now, however, investigations of virus activity have blurred the previous sharp distinction between the living and the non-living. Certain particles of matter with an inanimate type of structure have been found to have the power of multiplication of a living organism. These particles—the virus particles of infected plants—can multiply within a plant's own cells, and can thus cause plant disease.

Typical signs of virus disease in infected plants are a stunting of plant growth and a yellow mottling of the leaves (chlorosis). Gaining access to an appropriate plant cell, a single virus particle can multiply to millions of similar particles within a few hours, thus exhibiting one of the characteristics of living bacteria. This capacity of a virus for reproduction within living plants or animal cells is based upon its protein composition. Some plant viruses have been found to be pure protein molecules. In other virus particles (vaccinia virus), the presence of fatty and carbohydrate compounds has been reported [18]. Yet not even vaccinia, one of the largest and most complex of all viruses, has been found to show the independent metabolic activity characteristic of living cells. No virus, large or small, shows signs of respiration or fermentation, the two metabolic processes by which most living organisms derive the energy of life. Apart from their multiplication within the cells of animals or plants, virus particles show no sign of life, no motility, no metabolism.

Moreover, virus particles which infect plants are crystals, either two-dimensional or three-dimensional. The virus of bushy stunt disease of tomato plants, for example, consists of ultra-microscopic dodecahedral crystals, and thus has the structure of an inanimate body. Any crystal is a comparatively simple and static arrangement of atoms in a geometrical pattern of two or three spatial dimensions. The atoms of a crystal oscillate regularly about fixed positions. In a crystal, the wandering of an atom from one position to another is a comparatively uncommon occurrence, in sharp contrast to the ceaseless and complex molecular meanderings within a living cell. Moreover, a crystal contains only a small amount of water compared to the 70 to 90 per cent water content of a living organism. A virus crystal, therefore, is a particle which is inanimate in its structure and its lack of metabolic activity. Even in solution, plant-infecting virus particles 'contain no appreciable amount of water. It is their internal regularity, lack of water and chemical sim-

plicity that separate the viruses most sharply from the simplest recognised organisms (F. C. Bawden) [19].

Only one animal-infecting virus—that causing infantile paralysis—has so far been reported as having been isolated in the form of crystals. Nevertheless, in view of the absence of independent metabolic activity common to all viruses 'there is no reason to believe that viruses differ among themselves in any fundamental respect, or that there is other than a continuity of structure from small to large viruses' [20]. (W. M. Stanley.)

W. M. Stanley was the first to show that a plant virus shares with non-living matter a crystal type of structure. In 1935, this American chemist isolated the pure virus of tobacco mosaic disease and found that it consists of protein crystals: that is, of protein molecules with the ordered atomic arrangement typical of the solid state of matter. Concluding that the intracellular activity of virus particles is due to their nucleoprotein composition and specific atomic architecture, Stanley attributed virus disease to the peculiar power of multiplication of the virus particles within the living cells of infected plants or animals. 'The essence of virus activity is reproduction' [21].

How virus particles manage to multiply within living cells is still an unsolved problem. Apparently a virus derives the chemical constituents and the energy necessary for its reproduction from the living cells which it enters as an infecting agent. But whatever the precise mode of reproduction of a plant virus, its crystal structure separates it from the protoplasmic structure typical of living organisms.

Viruses thus bridge the gap between living and non-living matter—something which an anatomist—Frederick Wood Jones—was one of the first to grasp. In the words of W. T. Astbury, a leading British chemist, 'the boundaries are down between the living and the non-living, and we see "life" in perhaps its simplest possible manifestation of single chemical units' [22]. In its power of multiplication, a virus may be regarded as alive. On the other hand, absence of independent metabolic activity distinguishes a virus from living organisms, which obtain energy through the building up and breaking down of their own water-borne physico-chemical systems. Virus crystals cannot possess such metabolic activity, owing to the static type of ordered atomic architecture which they share with purely inanimate solid bodies. And yet in conjunction with the meta-

bolism of plant cells, these crystals can multiply, cause a definite plant disease, and infect other healthy plants with the same disease!

Bridging the gap between living and non-living matter, the existence of viruses does not alter the fact that living matter has its own specific qualities, differentiating it from the rest of nature. A single-cell organism that assimilates, excretes, divides and moves of its own accord is qualitatively distinct from a virus crystal no less than from a piece of stone. But the peculiarities of a living cell do not separate it *absolutely* from the sticks and stones of non-living matter. An extraordinarily complex set of physico-chemical conditions give rise to the phenomena of life. Cell life is a part of the material universe—a part which permits multicellular human beings to survey the universe as a whole. The mystery of this does not call for the mental prostration of mysticism. It calls for clearer thought, more illuminating experiments, greater imagination, a wider materialist outlook. This is the mental response that cell life makes possible, even in the first shuddering years of liberated atomic energy.

Chapter VI

TWO WOULD-BE MATERIALISTS

1 ERRORS OF A MECHANIST

ONE of the few recent philosophical works from a materialist point of view by a British author is *The Nature of Living Matter*, by Professor Lancelot Hogben. The view expressed is not that of dialectic materialism, but belongs rather to mechanistic materialism, inherited from the 18th century French materialism and akin to the 'behaviourism' of American writers. Professor Hogben also places a peculiar emphasis on a contrast between two elements of the subjective, namely *knowledge* of the material universe (the 'public world') and individual feelings—preferences, likes, dislikes, emotions, etc. ('private worlds'). This emphasis is accompanied by a shouldering aside of the core of materialism, i.e. the contention that the physical world exists independently of consciousness.

The key to Hogben's philosophy is the fact that he *identifies* mind and matter. Instead of understanding the nature of the *unity* of mind and matter, where matter is primary and mind secondary, he identifies mind and matter. As a result, at one moment his argument is solely concerned with a distinction between the 'public world' of science and the 'private worlds' of individual preferences (both 'worlds' being subjective). The next moment his argument is that of the mechanist for whom the subjective does not exist, and who would reduce mind to material processes. As an example of this mechanistic view we may take the following remark from *The Nature of Living Matter* :—

'A philosopher is a particular kind of organism. Philosophy itself might therefore be regarded as an aspect of the behaviour of a piece of living matter' [1].

Philosophy is here reduced to an individual material product, whereas for dialectic materialists philosophy is essentially an abstract social product—a system of *ideas*, which of course are derived fundamentally and historically from material social developments, are bound up with these, and furthermore react upon them in the process of history.

A further illustration of Hogben's mechanistic outlook is his suggestion that 'modern biological inquiry is disintegrating consciousness into an atomic nexus of reflex arcs' [2]. This is *identifying* consciousness with material processes of the body. Dialectic materialism on the other hand insists that consciousness is a *subjective derivative* of the objective material processes of the body. In the unity of mind and matter, mind is a *result* of matter organized in a certain way—of a material brain. Hogben's suggestion, however, follows the teaching of 'behaviourism', the mechanistic character of which will be considered later.

On the question of the unity of the universe, dialectic materialism regards the universe as one evolving unity by reason of its material nature. This *monistic* view of the universe is part of the foundation of modern materialism. Professor Hogben, however, prefers to dispense with monism, for he says: 'As scientific investigation invades the domain of conscious behaviour the way will be open for developing a new outlook in philosophy, one that is neither intrinsically monistic nor intrinsically pluralistic, since it makes no such claims to finality as the academic philosophies of the past have usually done' [3].

Any 'new outlook' which deserts monism admits the possibility of all kinds of fantasies, magical, mystic, religious, etc., for if the unity of the universe is denied, and if the dependence of mind on matter is set aside, then causality is also rejected; anything is possible; spirits may ride the air like the Valkyrie, disembodied souls may roam the earth, saints may perform miracles. . . .

Professor Hogben, having stepped over the threshold of the supernatural by deviating from monism, proceeds to shake hands with his dark host by depreciating the truths of science. Referring to the supernatural, he says: 'Magical views of the world have declined not because science has disproved them, but because science provides better ways of discussing the same issues' [4]. Also: 'We do not dismiss the hypothesis that thunderstorms occur when a blue unicorn sneezes on Uranus, because it is actually possible to disprove so engaging a fancy, but simply because other ways of treating thunderstorms lead to more useful conclusions' [5]. Each of these statements is a vulgarization of scientific truth—a reduction of modern materialism to the mere practical utility of science. As dialectic materialists we refuse to divorce the criterion of practice in

science (its practical utility) from the criterion of practice in epistemology, i.e. in connection with the grounds of our knowledge. In other words, practice not only provides the basis for establishing scientific theory, but also is the essential criterion for philosophical truth—for knowing that science gives us a picture of the independently existing physical world. The picture is fragmentary, approximate and necessarily incomplete, but it has enabled us to *disprove* magical views of the world. Science dismisses 'so engaging a fancy' as a blue unicorn sneezing on Uranus because the fantasy is contrary to virtually all existing scientific knowledge. Dialectic materialism recognizes that science is not only a source of practical utility—of dynamos, turbines, telephones and microscopes, but also a source of strength to philosophical truth—to modern materialism—to the view that our ideas are approximate reflections (or pictures, or images) of the physical world, which exists independently of thought. To those who would have us accept crazy fantasies, magical or religious, we say that they are contrary to scientific knowledge in general, that they are incapable of demonstrative proof, and that we reject them on established scientific principles. This does not mean that we reject a proposition *à priori*, i.e. because of some heaven-sent inspiration. No! we reject a new 'idea' as a fantasy when it is contrary to facts, to the general accumulation of scientific theory, and when no practical demonstrative evidence can be brought forward to support it.

With regard to Hogben's 'new outlook in philosophy', which will not be monistic (or pluralistic!), 'since it makes no such claims to finality as the academic philosophies of the past have done'—if by finality is meant absolute truth, then dialectic materialists will not hesitate to reply with an absolute truth, namely that the physical world, consisting of matter in motion, exists independently of consciousness, and that mind in the universe is secondary to matter. To deny 'finality', meaning absolute truth, in this respect is to strike at the roots of modern materialism and to sink into the quicksands of philosophical relativity.

While vulgarizing scientific knowledge by reducing it to nothing but a source of practical utility, and by divorcing the criterion of practice from the theory of knowledge, Professor Hogben introduces an idealist conception of knowledge, namely that *the* test of its validity is whether the majority accept it. He says: 'The mechanist is concerned with how to proceed to

a construction which will represent as much about the universe as human beings with their limited range of receptor organs can agree to accept' [6].

Hogben here substitutes for the approach to objective reality the subjective agreement of different human beings on what they will 'accept'. He adopts an agnostic attitude towards the physical world, for he doubts with Hume 'whether it is possible to attach any significance to deciding whether scientific beliefs are a faithful representation of "reality"' [7].

We can answer this doubt with the question: if scientific beliefs are not an (approximately) 'faithful' representation of an independent physical reality, then how comes it that different human beings agree at all in their ideas about the universe? Is it then some supernatural agency which gives different individuals similar ideas? Also, if there is no significance at all in deciding whether scientific beliefs are a representation of reality, then we are left only with sensations—with the agnosticism of Hume—strange company for a mechanist! Professor Hogben appears to have forgotten for the moment that scientific as well as all other beliefs are obtained through sensations. If objective reality is dismissed, then only the subjective—sensations, ideas—remains.

From doubting with Hume, Hogben sets out to show what he considers the fundamental problem of philosophy. We are told: 'Scientific beliefs are specially characterized by their communicability, or, to use the term which I shall employ more frequently, their *publicity*. The fundamental problem of a philosophy which does not presuppose what it sets out to establish is to find what characteristics of beliefs make them communicable' [8]. In other passages of *The Nature of Living Matter*, Hogben makes it clear that he sees the fundamental problem of philosophy as a distinguishing and a contrasting of the 'public world' of scientific knowledge and the 'private worlds' of individual ideas—preferences, personal opinions, emotions, etc. It is obvious that this is a contrasting of two subjective categories, of knowledge about the physical world with particular personal opinions. Furthermore, Hogben would have this contrast between two subjective categories substituted for the emphasis of dialectic materialism on the approximation of scientific knowledge to objective reality, as in the following:—

'Thus in contradistinction to the *reality* of traditional philosophy which is an individualistic concept, the concept of

publicity, which it is proposed to substitute as the goal of synthetic philosophy, is an essentially social one' [9]. In other words, materialists should not emphasize the independent reality of the material world. Materialists should cease to be materialists! Hogben is proposing to obliterate the fundamental nature of scientific knowledge, namely its correspondence, its 'close fit', with physical reality. He has picked up the words 'communicability' and 'publicity,' turning them into labels for scientific knowledge, so that the grounds of that knowledge are obscured. The materialist insistence on the derivation of mind from matter is denied as the crux of the problem. For the mechanist, matter and mind do not form a unity, in which matter is primary. Hogben, a mechanist, instead treats matter and mind as *identical*.

Professor Hogben's 'public world' is described as 'the domain of socialized belief' [10], and is contrasted with individual 'private worlds', consisting of personal opinions, likes, dislikes, etc., in connection for example with art or religion. But these 'private worlds' also consist largely of 'socialized belief'. It is true that an individual opinion may be altogether fantastic, bearing no relation to the general ideology of society beyond that of a fairy tale. An eccentric may regard the earth as flat, or a lunatic may believe himself to be the living Buddha, but even such fantastic ideas may be traceable to past or present 'socialized belief'. Fairy tales as well as scientific theories have their *social origins*, and in that sense may be regarded as 'socialized beliefs'. Another interpretation may be given to this phrase 'socialized beliefs', for it may mean that a section (or perhaps the whole) of society holds certain views. With such a meaning, 'socialized beliefs' would be so completely eclectic as to embrace almost every kind of opinion, from the views of a learned society to the cult of some primitive tribe. As for the views of the whole or the majority of society, these again include far more than the exactitudes of science. In fact, since in bourgeois society the views of the majority of society are coloured by the extreme prejudices of a degenerate minority, 'socialized belief' is apt to be very unreliable. Whatever meaning then is given to 'socialized belief', it cannot logically be restricted to scientific views.

Is there any method of investigating scientifically the nature of personal opinions, of ideas other than those of science? Can we correlate personal opinions—'private worlds'—with the reality

of nature and society? Is it possible to indicate how individual opinions—preferences, prejudices, beliefs—have arisen in the course of social development? There is such a method, and it is that of Marxism. Starting from the physical reality of society and the facts of its historical development, Marxism enables us to chart the course of social conflicts which underlie individual opinions and which have shaped culture. It is in the material forces of society and in the development of *social struggles* that we must seek the origin and nature of those *social* products—art, religion, current politics—which Professor Hogben chooses to box up into individual opinions and label ‘private worlds’.

With regard to those personal opinions which have no social significance, or which are irrelevant to a subject of study, it is naturally the aim of an investigator to eliminate as far as possible such opinions from his study. A dislike of cheese is naturally eliminated from an analysis of the composition of that foodstuff. An admiration for Rachmaninoff’s Prelude is eliminated from an investigation of the sound vibrations of its first note. This is a principle of science which is generally accepted, if not always followed. Professor Hogben, however, distorts this principle into a ‘special’ philosophy. He thereby confuses the fundamental issue of philosophical controversy, and hinders the growth of modern materialism in this country. Scientists endeavour to eliminate personal prejudices and subjective irrelevancies from their theories, so that a truer picture of nature may be obtained. Why philosophize this principle into a false contrast between ‘private worlds’ and the ‘public world’ of science, based on an alleged specific ‘communicability’ of scientific beliefs? Is not a dislike for cheese as ‘communicable’ as the nature of its composition? If Hogben will but recognize the independent reality of the physical world, he will have no need to introduce his false contrast in order to distinguish the basic features of scientific knowledge. Only dialectic materialism can give us a correct interpretation of science in its relation to the subjective aspects of other forms of culture.

Dialectic materialism does not of course deny that the ideas of science form a special category of thought in so far as they are representations of the real world. This, however, is a different matter to regarding science as a ‘world’ characterized by ‘communicability’ or ‘publicity’. What characterizes science are certain principles and methods, which should not be confused with the chief issue of philosophy, concerning the relation be-

tween our ideas and the physical world, between mind and matter.

Further confusion is apparent in Professor Hogben's writings, for example, with reference to solipsism: 'Under the influence of love or alcohol we have all been solipsists at one time or other' [11]. This of course is absurd. A solipsist is one who holds a particular point of view in philosophy, and not merely one who is egotistical, as the above statement implies. In the *Labour Monthly* of January, 1933, Hogben again refers irrelevantly to 'alcohol or love'. What sort of a bee is beneath this philosophical bonnet?

Hogben's same article in the *Labour Monthly* contains the following confusion concerning the line of division between idealists and materialists: 'From the standpoint of biology and psychology the current line of division lies in the fact that the idealist claims that his knowledge of himself is primary . . . The materialist affirms that our knowledge of ourselves is secondary to our knowledge of the evolving universe to which we belong'.

The mistake here lies in a failure to distinguish the essential claim of the idealist, namely that his knowledge not only of himself, *but also of the entire universe*, is primary, and that therefore matter is secondary to mind. The materialist, on the other hand, contends that our knowledge of ourselves *and* our knowledge of the universe (to which we belong) is secondary to the material universe. It is true that self-knowledge is secondary to knowledge of the external world, in so far as self-knowledge comes only with experience, but this is not the fundamental assertion of materialism, which is that knowledge of any kind is secondary to matter, since mind is derived from and is dependent on matter.

Armed with his errors of understanding, Hogben ventures to criticize the materialist Zavadovsky regarding the following passage from the latter's paper in *Science at the Cross Roads*: 'the dialectic conception of universal development—proved by Hegel and materialistically refashioned by Marx, Engels and Lenin—covers the Darwinian theory of organic evolution, which is the concrete expression of the dialectical process applied to the biological form of motion of matter'. Hogben terms this statement 'pure idealism'! Whatever misreading is made of Zavadovsky's remark, it is nevertheless a fact that the Darwinian theory is an (ideological) expression of the dialectical pro-

cess, and *is* applied to the biological form of matter in motion, i.e. to natural phenomena classed as biological. How is this idealism? And how is it idealism to say that the dialectical conception of universal development covers the Darwinian theory? Hogben's criticism (and the general trend of his writings) reveals a gross misunderstanding of the dialectic process, which belongs to the physical world and is every bit as objective as the paper on which Hogben wrote his hasty criticism. From a consideration of the dialectic process in nature and society, Hegel derived his dialectical *conception* of universal development, but made the mistake of attributing natural and social processes to the unfolding of a universal 'Spirit' or 'Idea'. Marx and Engels refashioned Hegel's conception, and showed that all ideas are derived historically from the material processes of nature and of society.

If Hogben could realize that the conception of the dialectic is derived from the contradictory relations and development of the material universe, he would perhaps be less ready to read idealism into Zavadovsky's paper. One who advocates 'recognizing the implications of the behaviourist standpoint' would do well to recognize the *materialism* of dialectic materialism, which gathered the grain of Hegel's logic while leaving behind the chaff of his idealism.

In spite of his limitations as a mechanist, Hogben has performed a valuable service in drawing attention to the latest brand of idealism, namely General Smuts' 'Holism'—an empire product adapted from Hegelian idealism. The following passage from Smuts' *Holism and Evolution* indicates its idealist character:—

'We find thus a great unifying creative tendency of a specific holistic character in the universe, operating through and sustaining the forces and activities of nature and life and mind, and giving even more of a distinctive holistic character to the universe. This creative tendency of principle we call Holism. Holism in all its endless forms is the principle which works up the raw material or unorganized energy units of the world, utilizes, assimilates and organizes them, endows them with specific structure and character and individuality and finally with personality, and creates beauty and truth and value from them' [12].

'Holism', a 'creative tendency' or 'principle', is analogous to Hegel's 'Absolute Idea', manifesting itself in the course of

evolution. Holism is a form of extended vitalism, of a general philosophical character. Smuts has thrown a bridge from Hegel's idealism to Muller's vitalism, and has termed his construction 'Holism', which is a supernatural invention disguised in philosophical form. *Holism and Evolution* subtly conveys the impression—altogether false—that it consists of entirely natural interpretations. The material character of the world is admitted. Matter is stated to have existed before the development of mind, but—there is a creative 'tendency' or 'principle', which is 'operating through' the forces and activities of nature. The cloven hoof of the supernatural appears! Holism 'utilizes' the energy of the world. Is not this reminiscent of theological dogma! Holism has 'endless forms'—a pantheistic note. Finally the term itself—'whole', leading to 'holistic'. A religious tone—introduced in a quiet, indirect way. . . .

We can break through the mystical twilight and religious half-tones of Holism with several blunt questions: Is the 'principle' of 'Holism' material in character? If not, then is it mental? If not mental, then supernatural! Whether mental or openly supernatural the result is essentially the same, for Holism is then a theological invention, allegedly directing the evolution of the material world. A mind determining the course of natural evolution is nothing but a theological fairy tale. A mind requires the functioning of a brain, and is a *result* of natural evolution. Once the reverse is assumed, once evolution is regarded as the result of the activities of a mind or 'principle', then theology is embraced. 'Holism' is obviously not a material entity. It is also not the result of the functioning of a brain. It is quite evidently a supernatural invention—a fantastic fiction.

Another mechanist point of view is presented by Professor Levy in *The Universe of Science*. Here science and knowledge in general appear as purely arbitrary constructions, consisting of isolated parts, termed 'systems' or 'isolates'. The unity of the world is obscured by a distorted emphasis on the discontinuity of our knowledge—on the relative isolation of its different elements. The basis of this error is again an identification of mind and matter. Levy does not realize that our ideas reflect the independent physical world, which in its material character is a unity. He sees knowledge only as isolated 'systems'.

While it is true that in studying one aspect of the physical world we exclude certain relationships as irrelevant, we nevertheless are not necessarily ignorant of the existence of such

relationships, and may indeed refer to them. For example, in considering a common object such as a tree, we may limit our thoughts to its size, shape and colour, but at the same time we are quite aware of other aspects and relationships of the tree—its molecular structure, the function of its chlorophyll, its connection with the soil, its relationship to evaporation, etc. Thus in contradiction to our thoughts of the tree as an isolated object there is our knowledge of the continuity of the tree with other natural phenomena. We see the tree as an isolated object, but we know that it is not isolated, to put the matter crudely. For Levy, however, a tree 'is virtually an isolated system as long as we are concerned with the lesser systems we can derive from it by further analysis—the bark, the shape and colour of the leaves, its fruit. . . .' [13].

Another example given of an 'isolate' is a child. We read: 'Here is a child. Almost as soon as the term child has been applied to it we have effected the isolation, for, in thought at any rate, we have dismissed its history, its family relationships, its home, and its country. . . .' [14]. Note that it is *the object itself* (tree or child) which is stated to be isolated. This is in contrast to the view of dialectic materialism, according to which our knowledge of an object is a mental image of it, a partial and approximate representation, which may include or exclude various aspects and relationships of the object. Professor Levy, however, makes no definite distinction between an object and our knowledge of it, and considers science as merely a search for 'systems'. He says. 'Science, like common sense, sets out in the first instance to search for *systems that can be imagined as isolated* from their setting in the universe. . . .' [15].

Is this view of the aim of science correct? Does not science rather set out in the first instance to search for truth about the physical world, for knowledge of its infinite aspects, its myriad elements, its countless qualities, its maze of relationships? Science, man's highest effort in the struggle against nature, seeks to observe, to correlate, to understand and to predict natural phenomena. Science is not an arbitrary imaginative construction of 'isolates', as Professor Levy would have us believe. The knowledge of science is a representation, fragmentary yet continuous, of the physical world. Science progresses by means of 'isolated' stepping stones, but these stepping stones of knowledge form a path. By following this path scientists gain more exact knowledge of the physical world and so attain

greater truth. As we shall see, Levy rejects the idea of truth in connection with science.

The following passages from *The Universe of Science* illustrate Levy's mechanistic outlook, in which the subjective and the objective, the general and the particular, the part and the whole—atoms, motion, electrons, measuring instruments, industrial specialization, science, the spectrum and the atomic theory—are all identified as 'isolates':—

'There are, in the first place, the purely theoretical isolates, atoms and electrons. . . . There are isolates like motion and position separated off from the moving body—sub-isolates, in fact—and handled as continuous entities. There are forces which the mathematician will handle in isolation. . . . Two billiard balls meet in impact, and the theoretician isolates from them merely what he would call the impulse on impact, and examines what effect is thus produced on that other isolate he calls the motion. . . .

'There are, next, the isolates of the experimenter. His measuring instruments, for example, are in effect attempts to obtain self-contained isolated systems. . . .

'The third form of isolate to which we must refer is of an even more practical nature. It emerges in production particularly, and is seen in the numerous forms of industrial specialization. . . . Every form of specialization is a form of isolation. Finally there are isolates of a sociological nature. . . .' (pp. 58-62).

What insight do the above quotations give us regarding Professor Levy's philosophical position? In the first place we may note that he describes as 'isolates' what a dialectic materialist regards as constituents of the physical world—atoms, electrons, measuring instruments and industry, for example. He regards atoms and electrons as '*purely theoretical isolates*', thus confusing the objective reality of atoms with our theoretical knowledge of atomic structure. In fact, Levy identifies matter and mind by making no distinction between what we can dimly comprehend (atoms, electrons, etc.) and the fragmentary comprehension itself (knowledge of atomic structure). This identification of mind and matter reveals itself throughout Levy's *Universe of Science* in an eclectic treatment as 'isolates' of natural objects and phenomena with abstract products of human society. 'Isolates' are made to include the spectrum (p. 60), the atomic theory (p. 148), and science itself, in fact, every phenomenon of the physical world and every mental

abstraction. In this way the distinction between the subjective and the objective is lost. The fragmentary and partial character of our knowledge is emphasized to the exclusion of its continuous element, derived from the continuity of the material universe. The very fact that we can pass logically from one idea to another, and successfully from one action to another—from one 'isolate' to another—demonstrates the continuity of our knowledge. Dialectic materialism recognizes both the discontinuous and the continuous elements of knowledge. Of these two contradictory elements Levy grasps only one—the discontinuous. Out of our method of gathering knowledge piecemeal—'in chips'—he creates a philosophy that portrays science and knowledge in general as more or less isolated 'systems', thus obscuring the dialectic character of knowledge, and its element of continuity in particular. This one-sided view is derived from an identification of mind and matter, which leads further to a rejection of truth in connection with science. Levy does not recognize that, in general and within limits, the success of scientific practice demonstrates the truth of scientific theory. He fails to understand that knowledge of the physical world, including scientific knowledge, is truth in so far as it approximates to the independently existing physical world. This lack of understanding of the nature of truth is expressed in the following passage of *The Universe of Science*: 'Truth is a dangerous word to incorporate within the vocabulary of science. It drags with it, in its train, ideas of permanence and immutability that are foreign to the spirit of a study that is essentially an historically changing movement, and that relies so much on practical examination within restricted circumstances. If it is true to say that the universe is for ever changing, that a situation once gone never recurs, then it is stupid to refer to the Laws of Science, based on such simple permanencies as measuring rods and clocks, as if each could equally well embody truth. Truth is an absolute notion that science, which is not concerned with any such permanency, had better leave alone. . . ' (pp. 206, 207).

It is evident that in grasping the ever changing character of the universe, Levy has become blinded to our knowledge of its actual existence! Is it not truth that the universe exists? And is not our knowledge of the material universe relatively true? Levy sees that everything changes, but fails to understand that our knowledge reflects change! Before realizing that we cannot step into the same river twice, Levy should really have assured

himself of the truth that rivers exist! Before putting on the spectacles of the dialectic, he should have understood the significance—the relative truth—of what his eyesight provides. As it is, an imperfect view of the dialectic has given him a severe attack of philosophical myopia.

Both Levy and Hogben derive much from Bertrand Russell's philosophical outlook. Russell's book, *The Scientific Outlook*, illustrates those errors which we have noted in the writings of these two would-be materialists. Russell too identifies mind and matter, but now from the point of view of an out-and-out idealist. For example, he believes 'there is little but prejudice and habit for the view that there is a world at all' [16]. According to Russell, 'we are led', via theoretical physics, 'to the position of Berkeley, according to which only thoughts exist' [17]. Speaking for those physicists who are subjective idealists, Russell says: 'The physicists of our day no longer believe in matter' [18].

Professors Levy and Hogben share Russell's identification of mind and matter, albeit as mechanists and not as idealists. Hogben's deviation from monism and Levy's disregard for the element of continuity in our knowledge are paralleled by Russell's outright rejection of the view that the world is a unity. Stating that this view 'has been considered the touchstone of wisdom', he says: 'The most fundamental of my intellectual beliefs is that this is rubbish. I think the universe is all spots and jumps, without continuity, without coherence or orderliness or any of the other properties that governesses love' [19].

Politeness forbids us the remark that Russell needs a governess to instruct him in a realistic view of the world! Of course 'jumps'—catastrophic changes—relative discontinuity—exist in the universe. So does continuity. The contradictory nature of all being has forced this view upon us. Dialectic materialism insists on the occurrence of 'jumps' in nature and society—and insists also on the unity of the world, by reason of its material character.

2. SCIENCE, ART, AND RELIGION

A favourite device of modern supporters of religion is to couple art and religion in contrast to science. It is stated by idealists and mystics that 'knowledge and truth' are to be found through art and religion as well as by means of science. Thus our knowledge of the physical world—of common objects,

atomic structure, biological processes and so on, is placed on the same plane as mental categories—æsthetic feelings, emotions, illusions, etc. Subjective ‘experiences’ are confused with knowledge of objective reality. Professor Arthur Thomson, for example, writes the following:

‘We see therefore that the scientific picture of the world is only one aspect of reality. Science can no longer be regarded as all that we can know. By its very nature science is limited to only one kind of knowledge, and it must always be so limited. The knowledge we think we gain through religion and art is not to be distrusted on scientific grounds. There are more ways than one of making contact with reality, and it is even more probable that our spiritual experiences bring us closer to the heart of this reality than science can ever do.’

A similar contrast is made by J. W. N. Sullivan, a writer quoted by Professor Hogben in *The Nature of Inving Matter* (p. 251):

‘The greater importance that men attach to art and religion . . . is not due simply to their ignorance of science. Art and religion satisfy deeper needs; the problems they deal with are intrinsically more important . . . our æsthetic and religious experiences need not lose the significance they appear to have merely because they are not taken into account in the scientific scheme’.

Hogben gives an extremely inadequate reply to Sullivan’s remark, which is typical of a common mode of attack on materialism. He replies that religion and art are two words ‘which are rarely used by any two people in the same sense or by any one person in the same sense on two successive occasions’. This is merely an evasion of the question of the relation of science to art on the one hand and to religion on the other. Hogben also relegates both ‘artistic values’ and ‘mystical experiences’ to the ‘private worlds’ of purely personal opinions. This again is an evasion of the question, for it places art and religion on an individualistic basis, and obscures the basic differences in their social content. It is true that Hogben opposes the social acceptance, the ‘public sanction’, of religious beliefs, but his opposition is on the grounds of a lack of so-called ‘communicability’, the characteristic possession of which by scientific views is said to confer ‘public sanction’. His criticism of religion is quite superficial, for it neglects the fact that religious beliefs are illusions, and the fact that religion exists to-day because of its value to

the ruling class of capitalist society. Hogben, instead of attacking religion as an essentially social product, with a definite class basis, advocates rather the limitation of mysticism and religion to purely individual opinions—to 'private worlds'. While opposing religious organization in society, he says that Professor Eddington 'has justified his right to a mystical experience' (p. 259). This is equivalent to a toleration of religious beliefs provided that an individual keeps them to himself. This indeed is Hogben's attitude, although it is disguised by describing purely individual religious beliefs as 'aesthetics' or 'ethics', as when he says: 'Whereas a person can have very genuine artistic interests without claiming a universal, transcendental or *public* sanction for his own preferences, *religion ceases to be religion and becomes aesthetics or ethics*, when it does not put forward such claims' (p. 252).

This attitude of tolerating religious views as 'aesthetics' or 'ethics' provided social or 'public' sanction is not claimed for them is a Liberal attitude, which seeks to seclude, but not to abolish religious and mystic beliefs. In the mansion of 'publicism' the ghost of mysticism which haunts it is confined to one wing of the house! Our task as dialectic materialists is to follow the ghosts of religion and mysticism into the seclusion of their 'private worlds', and expose their illusory character. We have to show that the beliefs of religion are illusions, however closely they may be locked in the breast of a single individual. The 'opium of the people' produces its dreams, which are no less unreal than the dreams of the opium of the poppy.

Hogben is unable to criticize religion as an illusion because he does not grasp the nature of the subjective—the dependence of the subjective on physical reality. He does not comprehend the materialist conception of a physical world independent of consciousness. He classifies beliefs not according to their relation to physical reality, but according to a vague 'communicability' (p. 261). Hence he is unable to show the *unreal* character of religious beliefs—their distorted nature and divorce from what exists in the physical world. *The supernatural* character of religious views escapes serious criticism in Hogben's philosophy. Lastly, the social origin and significance of religion is not shown. Hogben treats religion merely as something which should be confined to purely individual 'experiences', and then regarded as 'aesthetics'.

Idealists and mystics frequently refer to religion and art

conjointly, as if art was essentially akin to religion. Religion and art are both described as 'spiritual experiences', and as a pair are contrasted to science, which aims at an objective representation of physical reality. Art is based upon subjective impressions, and expresses our thoughts and feelings in various forms. Religious beliefs too are subjective in character, being imaginative products of thought. It is this connection between art and religion that is made use of by idealists and mystics in support of religion. *Religion, however, differs essentially from art in its supernatural beliefs, in claiming independent reality for its fantasies, in its call to prostration before a mythical Supreme Being, and in its social significance.*

In contrast to religion, art is not fixed rigidly as a form of class oppression. Certainly art has a class content—reflects the class struggle of society, but not in an *entirely* one-sided fashion. Art today is a vehicle for bourgeois propaganda, but it is also a means of expression of revolutionary thought. In embracing every phase and range of human sentiment, art provides an expression for all the aspirations and ambitions of mankind. Within the limits of a class framework, the masses can find their own needs in art, in spite of economic difficulties and bourgeois ideology. Furthermore, the way lies open for a mighty growth of art, once the economic foundations of society have been recast. In social significance, therefore, art differs essentially from religion.

Art, like religion, has its fantasies, but, unlike religion, does not claim for them a reality independent of human thought. Admirers of Wagner do not claim such independent reality for the Nibelung dwarfs and Rhine maidens of 'The Ring'! Readers of Shelley do not assert that a cloud ever actually soliloquized apart from his famous lyric! The symbolic figures of Watt's paintings are not held to represent flesh and blood beings!

The fantasies of art are derived fundamentally from the physical world, as is every form of thought. In art the earthly origin and mythical nature of fantasy is recognized. In the case of religion, however, its devotees claim heavenly inspiration for the origin of their fantasies, which are also endowed with an independent existence! In art, the natural is grasped, twisted, exaggerated, and transformed, but retains its quality of belonging to the universe. In religion, the natural becomes the supernatural, separated absolutely from all earthly ties.

In the gulf between art and religion hang the mystics, who

endeavour to give a transcendental, forever hidden significance to the dreams and efforts of artistic creation. .

'Science', wrote Bukharin, 'classifies, arranges, clarifies, eliminates the contradictions in, the thoughts of men; it constructs a complete raiment of scientific ideas and theories out of fragmentary knowledge. But social man not only thinks, he also feels; he suffers, enjoys, regrets, rejoices, mourns, despairs, etc.; his thoughts may be of infinite complexity and delicacy; his psychic experiences may be tuned according to this note or that. Art systematizes these feelings and expresses them in artistic form, in words, or in tones, in gestures (for example, the dance), or by other means, which sometimes are quite material, as in architecture. We may formulate this condition in others words: we may say, for example, that art is a means of "socializing the feelings"; or, as Leo Tolstoy correctly says in his book, art is a means of emotionally "infecting" men. The hearers of a musical work expressive of a certain mood will be "infected", permeated, with this mood; the feeling of the individual composer becomes the feelings of many persons, has been transferred to them, has "influenced" them; a psychic state has here been "socialized". The same holds good in any other art; painting, architecture, poetry, sculpture, etc.

'The nature of art is now clear; it is a systematization of feelings in forms; the direct function of art in socializing, transferring, disseminating these feelings, in society, is now also clear' [20].

The joint contrast of art and religion on the one hand to science on the other is seen to be quite unjustified, being merely a device to conceal the opposition of science to religion and the essential differences between art and religion. Science and art can be considered together, in being fertile forms of human culture. Religion, however, an inevitable phase of early culture, has become sterile, and is now equally inevitably a reactionary force inimical to the welfare of society.

It is generally known that science is not confined to the laboratories of schools and universities. The entry of science into all phases of everyday life is a commonplace fact. Less obvious is the relation of science to social movements. Where does science stand in relation to the currents of political life? Professor Levy, in his book *The Universe of Science*, has said that scientific work is not 'neutral' when its social significance is considered: 'Immediately the social purpose of a piece of

scientific work becomes apparent its ethical or social neutrality vanishes' (p. 222). As an example of the bias of expert opinion in applied science, this well-known scientist considers 'a mine accident or a railway disaster, or a factory explosion', concerning which 'some experts will demonstrate that as far as the owners were concerned all reasonable safeguards had been taken, while others show that the factor of safety was far too low for the workers' well-being'.

The conflict between owners and workers in industry is thus reproduced in the disagreements of experts in 'applied' science. In 'pure' science also the conflicting points of view of 'owners and workers' find expression, albeit in a different and less obvious fashion, when philosophical issues are raised. As opposed to materialism, we find expressions of idealism, vitalism, mysticism, etc., derived from historical currents of thought, and related to economic struggles. In Britain, opposition to these anti-scientific expressions takes chiefly the forms of mechanism and rationalism, the faults of which are eagerly seized upon by enemies of materialism. An adequate method of approach to the crises and basic problems of modern science is to be found only in dialectic materialism, which is not yet generally known in this country. Only in the U.S.S.R. is there a clear, general, planned progress of science based on modern materialist philosophy.

The future of science depends on the success of dialectic materialism in replacing existing idealistic views on the one hand and mechanistic views on the other. Without a revolutionary transformation of society this success cannot take place. Nevertheless, by means of modern materialism we can already discern the sources of theoretical confusion in contemporary science, and the way out of that confusion. We can realize also how science can develop on a mass scale, once full scope is given for general scientific education and research. As opposed to the idea of such a development, certain writers picture the possible evolution of science into an esoteric cult of a select minority. This last is the vision—or the nightmare—of Bertrand Russell. Without following the contradictory nature of the tendencies and difficulties of present-day science, Russell imagines a straight line development of certain of its features, namely the limiting of much scientific knowledge to small circles of individuals, restriction of the benefits of science to a minority class, mal-direction of research, and a mechanistic outlook on the world.

In Russell's hypothetical society of the future 'a great deal of scientific knowledge will be concealed from all but a few' [21]. There will be a 'priestly class of researchers' [22]. In contrast to the education of the children of 'ordinary' men and women, those children 'who are destined to become members of the governing class will have a very different education. . . . All the best known science will be applied to the simultaneous development of intelligence and will-power. . . . The scientific outlook will be instilled from the moment that a child can talk, and throughout the early impressionable years the child will be carefully guarded from contact with the ignorant and unscientific. . . .' [23]. Emotions and æsthetic feelings will be subdued in the rulers of Russell's society by asceticism, which will generate 'sadistic impulses', that 'will find an outlet in scientific experiment. . . . The advancement of knowledge will be held to justify much torture of individuals by surgeons, biochemists and experimental psychologists . . . the new scientific religion will demand its holocausts of sacred victims In the end such a system must break down either in an orgy of bloodshed or in the rediscovery of joy' [24].

Russell's hypothetical class society, with its oligarchy of scientists imposing their will on others, is an imaginative solution of the contradictions of capitalism. His 'world State', a variety of ultra-imperialistic demagoguery, relieves the ruling class of the problems of national antagonisms, war and revolutionary upheavals. Science becomes a means of creating, not social contradictions or a general cultural advance, but greater social power for an oligarchy of scientists. Science, it is supposed, would produce a mass of contented slaves on the one hand, and an all-powerful master class on the other. The rulers of society, it is said, would ultimately perish through their own innate savagery, unless a 'rediscovery of joy' occurred (with presumably slaves and masters dancing round a maypole in an idyll of class collaboration!).

Russell can imagine every 'external' difficulty of capitalist society removed with the aid of science, but cannot see how the 'sadistic impulses' of mankind could be eliminated. He does not understand that 'sadistic impulses' and all subjective tendencies depend on man's relation to nature, on the one hand, and on social forces and organizations on the other. Such writers suppose that 'human nature' is a more or less fixed entity, inherited from heaven, hell or the amoeba, according to their

respective convictions. Hence their prophecies invariably end in despair, or in such absurdities as the 'rediscovery of joy'. They cannot transcend the mentality of their class, which is rife with 'sadistic impulses', as well as every other kind of psycho-pathological aberration. Consequently, in Russell's society of the future, class divisions and the worst features of 'human nature' survive.

Russell visualizes the transformation of science into a cult, and of scientists into an independent class of political rulers. In present-day society, scientists do not form a class, although the majority of them may belong to one class. Scientists at present are the servants of a class. The scientific movement is not an independent force in society. Certain writers, such as Russell, dream of scientists becoming masters instead of servants politically. This dream is an expression of a wish to give to science an independent political objective. It amounts to a proposal that responsibility for the social application of science should be transferred to scientists themselves. This proposal has found discreet utterance from time to time in the British journal *Nature*, and spectacular publicity in American 'Technocracy'. Its fallacy is a disregard of the fact that political power proceeds not from idealistic schemata but from economic interests.

How far the scientist has become the servant of the politician is evident from events preceding and following the launching of the first atomic bomb. In January, 1939, the nuclear fission hypothesis was published in Germany by Hahn and Strassmann. In the spring of 1939, a group of foreign-born physicists in the U.S.A. 'enlisted Niels Bohr's co-operation in an attempt to stop publication of further data by voluntary agreement' [25]. In the autumn of 1939, the first government committee on nuclear fission was set up. In 1940, a censorship descended on all American scientific journals, immediately following the first government subsidy for work on nuclear fission. In 1941, British scientists were consulted about the government project of tapping atomic energy for politico-military purposes. In 1942, an army officer—General L. R. Groves—was given 'the major responsibility for correlating the whole effort and keeping it directed towards its military objectives'. In 1943, 'the period of complete army control began', embracing visiting British scientists.

On July 14, 1945, the first atomic bomb was dropped from a

steel tower in the New Mexico desert, blinding a man who stood six miles away. On August 6, 1945, the second atomic bomb was dropped—on Hiroshima, killing between 70,000 and 120,000 men, women and children.

With this deed, science bowed its head before a political master deliberately removing a velvet glove. Is it not obvious, said the President of the Royal Society a few days later, that, 'with the closing stages of this war, scientific discovery and invention are becoming the essential combatants? Science, an unwilling conscript, is becoming the direct agent of indiscriminating devastation at long range. . . .'

Practically simultaneously with this remark, military counter-espionage agents of the United States government visited the Columbia University office of Harold Jacobson, one of the scientists who had participated in the atomic research. Jacobson, who had written an article stating that the bombed area of Japan might cause the death of persons entering the area for a period of seventy years, was told by his visitors that he could be imprisoned for violating military secrecy with his article. Harold Jacobson was the first but probably not the last scientist to collapse in his chair at such a warning [26]

At the end of October, 1945, the May-Johnson Bill gave American scientists a blue-print of their own future. 'This Bill created a "Dictator of Science". To explore the atomic mysteries of chlorophyll a biologist would require a licence. Medical discoveries of far-reaching benefit to mankind could be locked away by the Military. For jotting figures on a pad, a mathematician could be fined 100,000 dollars, gaoled for ten years' [27].

Mechanized warfare, aviation, chemistry and physics have brought scientists face to face with soldiers and politicians who have not been slow to assert their superior authority. History has not cast the scientist for the role of master of society. Laboratory learning does not produce specialists in social affairs. Between the scientist and social power stands the policeman, an individual more accustomed to the law and order of bureaucratic authority than to the laws and orderliness of natural science. Neither the policemen nor the soldier is likely to gaoil the politician at the request of the scientist whose rational outlook is outraged by the irrationality of capitalist society. No matter how loudly conscience-stricken scientists may lament misuse of their discoveries, such misuse will continue until a world government arises out of genuine democracy. The res-

possibility of scientists is to decide which class can preserve the products of science from catastrophic misuse, not to flatter themselves with a non-existent political independence.

Given a world government based on genuine democracy, science can satisfy the essential wants of all. Making war on poverty, ignorance and disease, scientists free from their present restraints can fulfil the ideals which inspired the great pioneers of modern discovery. Atomic energy, combined with other sources of power, is capable of enriching life to make a golden age. Nothing stands in the way except the present forms of social organization—the present title deeds, laws, institutes, establishments and frontiers, supported or tolerated by many on account of a drug-like ideology. Yet even now, in the midst of black depression, a new system of society is in process of being born. Blinded by illusions, poisoned with words and frustrated at every turn, the peoples of the world are nevertheless fighting a way towards their own united rule. Under that rule, neither the nightmare of Bertrand Russell nor the horror of the atomic bomb will disturb the harmonious application of science by a co-operative society.

In the society of the future, science will become popular in the widest sense of the word. The 'man in the street' will be equally at home in the laboratory. The 'plain man' will be engaged in highly complex work. Scientific projects will be undertaken collectively by groups of men and women. International Congresses of Science will be closely followed by millions of people. In the U.S.S.R. we have evidence of the leap forward in science and education that follows political liberation. On a world scale, the advances of the U.S.S.R. can be exceeded a thousand times by the international proletariat, and a thousand times again by the classless society of a more distant future. Far from becoming an esoteric cult, science will become deeply rooted in the masses, and a secure defence of the peoples of the world against any attempt to deprive them of their political gains.

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Chapter VII

SPACE AND TIME

1. ONE IDEALIST CORRECTS ANOTHER

IDEALISTS sometimes endeavour to escape from the weight of scientific evidence about the age of the earth, and its existence before man appeared, by denying the objective reality of time. Time is regarded as subjective, and dependent for its reality on mind. This subjective interpretation of time was given by Kant, who made time, as Professor Haldane says, a 'part of Mind'. It then becomes impossible to say that the earth existed before man, for time, as well as the earth, is said to depend for its reality on man's perceptions. This argument has gained favour since Einstein formulated the theory of relativity, which has altered our *conception* of time. Einstein having shown Newton's conception of *absolute* time to be incorrect, certain subjective idealists have seized on his arguments to declare that since time is relative, it must depend on each individual's conception of it, so that time has no objective reality apart from human consciousness. Actually Einstein demonstrated clearly the reality of space and time independent of consciousness. The advantages which subjective idealists seek from their argument is seen in a criticism of a statement by J. C. Smuts which Professor Haldane makes in *The Sciences and Philosophy*. He first quotes Smuts' statement that the earth existed for ages before mind (or 'Spirit').

Smuts asks: 'Where was the Spirit when the warm Silurian seas covered the face of the earth, and the lower types of fishes and marine creatures still formed the crest of the evolutionary wave? Or going still further back, where was the Spirit when in the Pre-Cambrian system of the globe the first convulsive movements threw up the early mountains which have now entirely disappeared from the face of the earth, and when the living forms, if any, were of so slow a type that none have been deciphered yet in the geological record? Where was the Spirit when the Solar System itself was still a diffuse fiery nebula?' Smuts himself replies: '*The evolutionary facts of Science are beyond dispute, and they support the view of the earth as existing*

millions of years before ever the psychical or Spiritual order had arisen' [1].

This graphic description of what science has proved to be true did not suit Professor Haldane, who hastened to correct his fellow idealist. He said: 'It seems to me that in putting these questions and arguing in this way, General Smuts has forgotten a previous question which was put by Kant, himself the author of a nebular theory of the origin of the solar system. That previous question concerned the nature of time. From an analysis of conscious experience he drew the conclusion that time can only be a form in accordance with which, owing to the nature of Mind, our conscious experience is arranged. In other words, *time is part of Mind*, so that in the remoteness of Newtonian time, mind or Spirit is still present, and we have not passed outside of its wholeness. In my sixth lecture I endeavoured to develop Kant's argument still further by pointing out that the wholeness which is expressed in conscious behaviour, whether that behaviour is called perception or voluntary response, is a wholeness which includes order in time as well as order in space. . . . The order of time as well as space is thus just a part of the expression of the *Spiritual whole* which is embodied in conscious behaviour. *That Spiritual whole leaves nothing outside itself, and cannot be identified with what is interpreted as a mere individual existence with its here and now*' [2].

Haldane first makes sure of his idealist position by bringing forward Kant's argument that time is a part of mind. No awkward questions can then be asked by materialists as to where mind was when the earth had not evolved beyond a state of molten or gaseous matter without life. Haldane then attempts to extricate himself from the difficulty that if a mind is part of an individual, then the earth could not have existed before the individual appeared! This absurdity is avoided by passing with great agility from Kant to Hegelian idealism, according to which the evolution of the world is the unfolding of an 'Absolute Idea'. Haldane separates mind, or 'Spirit', from any one individual, and makes it into a 'Spiritual whole' which 'leaves nothing outside itself', that is, which includes the world. This 'spiritual whole', which corresponds to Hegel's 'Absolute Idea', in its expression has time and space as part of itself. Haldane's 'spiritual whole' is an idealist conception concealing a diluted theology. The world (with space and time) is taken as the expression of something mental, or spiritual—a theological fiction exposed

by Lenin in his *Materialism and Empirio-Criticism*. Those who imagine anything mental or spiritual apart from individual existence are simply pursuing Hegel's 'lifeless abstraction', or preaching plain theology. Smuts' idealism also is in fact of the Hegelian 'objective' variety, notwithstanding his statement of the earth 'existing millions of years before ever the Psychological or Spiritual order had arisen.'

2. THE NATURE OF SPACE AND TIME

The 'crisis in physics' has been accentuated in recent years by the theory of relativity. Einstein has shown that *our conceptions* of space and time are relative; that *our measurements* of space or of time have meaning only in relation to some specified 'reference body' or 'co-ordinate system'. He says: 'Every reference-body (co-ordinate system) has its own particular time; unless we are told the reference-body to which the statement of time refers, there is no meaning in a statement of the time of an event' [3]. The theory of relativity has shown the relative character of our knowledge of space and time, but *this does not mean that there is no space or time apart from our conception of it*. The mistake which many idealists make is to confuse the changes and relativity of our knowledge of space and time with the independent existence of objects in space and time. This was the mistake of certain Russian writers who were followers of Mach, e.g. V. Bazarov.

Lenin, in criticizing Bazarov's mistake with reference to our conceptions of space and time, said: '*He confused their exclusively relative character with the absolute truth that man and nature exist only in space and time*. He fails to see that the *non-spatial* and *non-temporal* beings which are invented by the clergy and are given credence by the ignorant fancy of the down-trodden masses, are products of a diseased mind, artful deceptions of philosophical idealism—bad products of a bad social order. The scientific doctrine of the structure of substance, the chemical composition of food, and the electron may become antiquated with time; but the truth that man is unable to subsist on thoughts and beget children by platonic love alone can never become antiquated! *And a philosophy which denies the objectivity of time and space is just as absurd, just as essentially foul and false as one which denies these several truths*' [4].

Einstein has emphasized that '*space and time data have a physically real, and not a mere fictitious significance*' [5]. However he may lean at times towards idealism, he is here in agreement with the materialist view. Einstein confirms the stand of materialism in his work on the nature of space and time. Frederick Engels, who with Marx was one of the founders of modern materialism, defined space and time as 'the fundamental forms of all being', and said that 'being outside of time is just as much of an absurdity as being outside of space'. The converse is equally true, namely that space and time apart from being is an absurdity. Just as nothing in the universe can be outside space and time, so space and time apart from the physical universe is meaningless. Space and time are objective *forms of beings*.

Space has not the absolute character of a 'container' of matter, as was previously thought. It is now realized that space and time, which dialectic materialism has always maintained are fundamental forms of being, are not absolute, in the sense of independent and apart from matter. The physical universe is in a state of constant change, of which space and time are not independent. Physical events are changes of matter, of which space and time are fundamental forms. The physical reality of space and time lies in physical events themselves. Newtonian physics, however, regarded space and time as having an absolute existence, apart from matter and independent of physical events. Relativity physics recognizes that space and time do not exist apart from matter and are physical realities 'only' in physical events. Einstein, in criticizing Newtonian mechanics, puts the contrast with modern physics as follows:

'One spoke of points of space, as of instants of time, as if they were absolute realities. It was not observed that the true element of the space-time specifications was the event, specified by the four symbols x_1, x_2, x_3, t . . . It is neither the point in space, nor the instant in time, at which something happens that has physical reality, but only the event itself' [6].

Newton's conception of space is contrasted with the point of view of dialectic materialism by Professor B. Hessen, in his paper on the social and economic roots of Newton's work. Hessen says:

'Dialectic materialism considers space as a form of existence of matter. Space and time are the root conditions of the existence of all being(s), and therefore space is inseparable from matter. All matter exists in space, but space exists only in

matter. Empty space divorced from matter is only a logical or mathematical abstraction, the fruit of the activities of our minds, to which no real thing corresponds.

'According to Newton's thesis space can be divorced from matter,' and absolute space preserves its absolute properties because it exists independently of matter.

'Material bodies are found in space, as in a kind of receptacle. Newton's space is not a form of the existence of matter, but only a receptacle independent of these bodies and existing independently' (*Science at the Cross Roads*).

It will be noted that Einstein's statement on the nature of space and time supports the point of view of dialectic materialism. Both of the statements just quoted indicate that space and time exist only in physical events, that is, in matter. A physical event consists of particular changes in the material universe; matter undergoes some transformation. Every event possesses certain spatio-temporal relations, which are of basic importance in a scientific investigation of the event.

In mathematical investigations spatio-temporal relations are considered as abstractions. Observations and measurements made in connection with a natural process are dealt with in a logical manner which eliminates the concrete elements of the process to a greater or less extent. The abstractions of mathematics permit a logical train of thought to reach conclusions otherwise unobtainable. These conclusions, when applied to physical reality, may then be the means of revealing previously unknown facts. But while the exactitudes of mathematics proceed from the abstract nature of the science, mathematical conclusions can be verified in the last resort only by reference to physical reality. Thus the mathematical treatment of space and time can be shown to correspond to reality only by taking physical events into account.

For example, Einstein produced the theory of relativity as a result of abstract mathematical calculations, in which empirical observation played a comparatively small part. He says: 'The characteristics which especially distinguish the General Theory of Relativity and even more the new third stage of the theory, the Unitary Field Theory, from other physical theories, are the degree of formal speculation, the slender empirical basis, the boldness in theoretical construction, and finally the fundamental reliance on the uniformity of the secrets of natural law and their accessibility to the speculative intellect' [7].

From the theory of relativity Einstein drew certain conclusions about phenomena of the physical world. He deduced from his theory that certain occurrences took place with regard to physical events open to observation. He said that light reaching us from the stars was deflected by the sun, and that the spectral lines of light from the large stars (their light split up into colours by the spectroscope) were displaced (towards the red). Einstein's own words with regard to his deductions—before they were tested experimentally—were as follows:

'Apart from this one' [i.e. a deduction concerning the orbit of the planet Mercury] 'it has hitherto been possible to make only two deductions from the theory which admit of being tested by observation, to wit, the curvature of light rays by the gravitational field of the sun, and a displacement of the spectral lines of light reaching us from large stars, as compared with the corresponding lines for light produced in an analogous manner terrestrially (i.e. by the same kind of molecule). I do not doubt that these deductions from the theory will be confirmed also' [8].

Einstein's deductions were confirmed by observation. The abstract conclusions reached by mathematical theory were shown to represent objective reality only by observation of physical events. Einstein recognized this in saying: '*If the displacement of spectral lines towards the Red by the gravitational potential does not exist, then the general theory of relativity will be untenable*' [9]. Also, for the application of mathematics to reality, 'geometry must be stripped of its logical formal [i.e. purely abstract] character by the co-ordination of *real objects* of experience with the empty conceptual framework of axiomatic [i.e. of the logical formal] geometry' [10]. This emphasis on the necessity for correlating mathematics with the facts of observation in order to obtain objective truth is a correction to those idealists who treat mathematics as an *a priori* source of truth.

For a number of idealists, Einstein's theories afford an opportunity to declare again that 'matter has disappeared'. Only 'events are said to have reality, and an 'event' is some vague nebulousity of which one talks mystically to mystified audiences. Professor Whitehead, for example, says that the realities of nature are 'the events in nature' [11]. But when he comes to what an event is, he gives a jumble of metaphysical jargon in which finding matter is like looking for a needle in a haystack. We are told, for instance, that an actual 'event' is an 'achieve-

ment for its own sake, a grasping of diverse entities into a value by reason of their real togetherness in that pattern, to the exclusion of other entities' [12]. We also learn that an event 'is the grasping into unity of a pattern of aspects' [13], and that it 'constitutes a patterned value with a permanence inherent throughout its parts' [14]. The result of Professor Whitehead's discourses on the events of nature is a negative one, for matter and energy—the physical basis of the universe—disappear in a welter of words. That is the event of chief importance in Professor Whitehead's description of 'events' in nature.

It has already been shown that Whitehead's 'events' are mental in character, and now he tells us that space-time 'is the specification of certain general characteristics of *events* and of their mutual ordering' [15]. Space and time are said to be '*abstractions* from the totality of prehensive unifications as mutually patterned in each other' [16]. Thus in so far as Professor Whitehead's obscure metaphysical language can be deciphered, it is evident that he regards space and time as subjective, i.e. as dependent upon mind for their existence.

Whitehead regards space and time, not as forms of being, but as part of 'experience'. He refers to a region of space-time as a 'standpoint', which is itself 'a unit of realized experience' [17]. This is somewhat similar to the opinion of one of Mach's early followers (A. Bogdanov), who said that space and time were 'forms of social agreement of the experiences of different people' [18]. Whitehead, who does not bring society into his discussion, regards space and time as multiple subjective 'units' of different individuals.

The use of the word 'experience' is part of a time-worn argument of subjective idealism, namely that thought and reality are inseparable, because reality can only be conceived in thought, and thought involves the presence of the thinker. Reality becomes human 'experience', which includes space, time, the physical world, *as well as* '*revelations*', *religious 'experiences'* and *so forth*. The doctrine of 'essential co-ordination' (of Avenarius) was based on this subjective interpretation of 'experience'. Space and time then become forms, or 'units' of 'experience'. Mysticism is thus able to find a footing, and to postulate all kinds of ghosts, gods and devils, inside or outside of space and time, for whom reality is claimed because they are said to enter into our 'experience'.

The materialist interpretation of experience is that phenomena

of the independently existing world, acting on our sense-organs, forms the basis of our experience. From that basis we create not only images of the physical world, approximating to reality, but also distortions, exaggerations, piecemeal separations and combinations, and kaleidoscopic variations of those images. In other words, we possess not only truth about reality, but also that wealth of subjective fancy termed imagination. When imaginative products of mind are included as 'experience', then objective truth is confused with subjective fancy, the physical basis of experience is obscured, and finally matter is identified with mind.

Bertrand Russell is another writer who propounds a theory of space-time as 'a structure of events' [19] in which matter conveniently disappears. Time is said to be derived by data—'by inferences . . . which allow us to know only the logical or mathematical properties of what we infer' [20]. Russell adds: 'Thus it would seem that, wherever we infer from perceptions, it is only the structure that we can validly infer; and structure is what can be expressed by mathematical logic, which includes mathematics' [21]. Here logic and mathematics (Russell's own subjects) are enthroned as the only truth available to mankind! There is but one God, and Mahomet is his prophet! Space-time is said to be a 'structure of events', and as was shown in an earlier chapter, Russell's 'events' are of a mental nature, being, in the first place, 'percepts'. Thus space-time is made out to be essentially subjective, and dependent on human percepts for its reality.

The subjective point of view which Russell here puts forward is related to that of Ernst Mach who said: 'Space and time are well-ordered systems of series of sensations' [22]. Mach was more outspoken in his idealism than is Bertrand Russell, but both treat space and time subjectively, just as they do the physical world generally. Mach built his world out of 'elements', which were 'complexes of sensations', i.e. mental in nature. Russell makes out the world to consist of 'events', which are also primarily mental, and of which space and time are composed. Russell further resembles Mach in calling his world structure 'neutral' (mind as well as matter is a logical structure composed of 'neutral-stuff') [23]. Mach's world elements were also 'neutral' (although they were also sensations!). However, 'events' are now more popular among subjective idealists than 'elements'. 'Events' are used by subjective idealists in their philosophical

writings in attempts to gloss over the distinction between mind and matter, and the all important question as to which is primary. Then, almost casually, we are given to understand that 'events' must, of course, be 'in the first place, percepts' (Russell), or 'apprehensions' (Whitehead)—that is, they are mental!

Einstein has protested against the twisting of his scientific theories into philosophical speculations. The following statement attributed to him in a newspaper interview is a fitting correction to those who misuse conceptions of relativity physics in the speculations of subjective idealism:

'The meaning of relativity', Einstein is reported to have said, 'has been widely misunderstood. Philosophers play with the word like a child with a doll.

'Relativity, as I see it, merely denotes that certain physical and mechanical facts, which have been regarded as positive and permanent, are relative with regard to certain other facts in the sphere of physics and mechanics.

'It does not mean that everything in life is relative and that we have the right to turn the whole world mischievously topsy-turvy' [24].

The absolute space and time of Newtonian mechanics are abandoned in relativity physics, although these conceptions are still applicable within certain limits. It is now recognized that these absolute features of pre-relativity physics do not correctly represent space and time in the physical universe. Space and time are now thought to be inextricably bound up with the events of the physical world. Absolute space and time, divorced from matter as a 'receptacle' bounding matter, is an obsolete conception. However, this does not alter the fact that space and time are fundamental forms of being and that the idea of a physical phenomenon apart from space and time is an absurdity. Man exists only in space and time. Mathematics has reached the 'conclusion that 'the world in which we live is a four-dimensional space-time continuum' [25]. As materialists we say that man exists in a physical universe of which space and time are fundamental forms of being.

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Chapter VIII

BRAIN AND MIND

1. REFLEXES OF THE BRAIN

THE experimental work of Professor Pavlov and his followers has added a vast amount to our knowledge of brain function. The work reveals something of those neurological processes which result in consciousness, and the variation of mental states. Before Pavlov's results were obtained, the relation between the study of the brain and the study of mind was a distant one. Neurologists were generally aware that the functioning of the brain produced mental states, while psychologists realized that mind was dependent on brain, but the physiology of the brain was not directly and intimately connected with psychology—with the study of mind. Now, however, Pavlov has enabled us to perceive an outline of what particular cerebral processes are concerned with the production of mental states. Previously, neurology had been able to show us details of those nervous processes underlying involuntary behaviour (for example, the jerk of the leg following a tap below the knee). Now we have demonstrative evidence of nervous processes underlying voluntary behaviour. The neurological basis of the conscious voluntary actions of an individual are now revealed in partial outline for the first time. The reactions of an individual to his environment are illuminated by a knowledge of the cortical processes concerned.

Pavlov has scarcely attempted to correlate the reactions of an individual with the various phases of his mental life. Such a correlation is a task for future investigators. The present gains consist of a knowledge of reflexes of the brain, which we know to be closely concerned with the creation of mental states. Thus a link between our knowledge of an individual's environment and his mental attitude to that environment has been forged, if not fitted, by Pavlov's work on the reflexes of the brain.

In contrast to the subjective explanations of psychology, which refer the actions of an individual to his mental condition, Pavlov refers an individual's reactions to particular features of his immediate external surroundings, and refuses to consider

mental categories. This refusal to consider the subjective, while adding to the unitary and self-contained character of Pavlov's work, can at the same time place limitations upon its further development. A consistent refusal to connect in any way the objective reactions of an individual with his mental states would be tantamount to a denial of the existence of those mental states, in the event of opportunities arising for correlating them with bodily reactions. Such an attitude would remove from reach and use the data and results of psychology, which are rich and promising, however indistinct and uncoordinated they may be. To Pavlov, it appears that 'the position of psychology as a study of subjective states is completely hopeless' [1].

The crisis and confusion in psychology is due chiefly to the exclusive domination of subjective interpretations of behaviour. Instead of working from physiology and the sociological sciences towards the subjective, psychologists have drawn unscientifically and prematurely on their own subjective feelings in interpreting human actions. Since each psychologist possesses his own individual subjective outlook, the result has been chaos in psychology. But now that science has enabled psychologists to connect mental states to environment through brain physiology, psychology can begin the task of tracing the creation of mental states on the basis of physiology, sociology and the objective methods of science in general. Psychology, while embracing the subjective, while studying mental states, can feel firm ground beneath its feet in brain physiology and the sociological method of Marxism. A revolutionary and limitless prospect is thus opened. The advance of science on human behaviour and mentality awaits a general understanding of modern materialism, and—the prerequisite social conditions!

Pavlov's work concerns the reactions of the higher animals to their environment. The reaction of an animal to a stimulus of its environment is termed a reflex. A stimulus produces a nervous impulse, which travels by a reflex arc or path. 'In the lower central nervous system there are recognized three parts of this arc: the *receptor* (a receiving apparatus), *conductor* (conducting apparatus), and the *effector* (the apparatus which exercises the special activity)' [2]. Pavlov has shown that the higher central nervous system also functions in a reflex fashion. Through the cortex of the brain reflexes of a qualitatively distinct character are elaborated.

Animal reactions are analysed into *unconditioned* and *con-*

ditioned reflexes. An *unconditioned reflex* is described as 'the reaction of the organism to the external world, effected through the nervous system, by which an external stimulus is transformed into a nervous process and transmitted along a circuitous route . . . until, reaching one or another organ, it excites its activity. This reaction is specific and permanent' [8]. An example of an unconditioned reflex is the grasping by an infant of anything put into its hand. Pavlov terms this the 'grasping reflex'. An unconditioned reflex is inborn and permanent. A *conditioned reflex*, on the other hand, is a reaction not inborn in the organism; it has to be built up by association, direct or indirect, with unconditioned reflexes. It is the reflex which occurs, for example, when a dog 'licks its chops' (salivates) at the sight of meat. Salivation of the dog at the mere sight of meat was on some previous occasion caused by an *accompanying contact of meat with the dog's mouth, which is the specific stimulus to the inborn, unconditioned reflex of salivation*.

Similarly, a dog will salivate on the ringing of a bell, if on previous occasions it has been fed just after the ringing of the bell. Parallel experiments on human beings suggest that the reactions of all the higher animals, including man, are based on conditioned and unconditioned reflexes. Pavlov describes reflexes of defence, of inhibition, of collecting, and of sleep. Conditioned reflexes he describes as 'temporary and conditional . . . their formation and extinction are determined by (one or several) coincidences in time of stimulation of the lower lying reflex centres . . . with the stimulation of the cerebral hemispheres through the corresponding centripetal nerves' [4].

These new, conditioned reflexes 'are the function of the highest structure of the nervous system of the animal'. By means of them temporary connections are established between an organism and the elements of the external world to which it reacts. The highest development of the nervous system is the cerebral hemispheres, which are most highly developed in man. It is these portions of the brain whose function includes the formation of conditioned reflexes. Pavlov says of this function: 'From the standpoint of the conditioned reflexes the *cerebral hemispheres* appear as a *complex of analysers*, whose functions are: to *decompose* the intricacy of the outer and inner worlds into their separate elements and components, and further to *connect* all these with the manifold activity of the organism' [5].

In comparing the reflexes of the brain with those of the lower

nervous centres Pavlov says: 'Add to "receptor" the word "analyser" (decomposing), and to "conductor" the word "connector" (linking or coupling apparatus), and you have the expressions for the corresponding anatomical structure for the two fundamental activities which characterize the higher part of the central nervous system' [6].

Pavlov's interpretation of the function of the brain in the activities of an animal organism is as follows: 'The basic activities of the higher parts of the central nervous system are: first, the coupling or linking of new temporary connections between certain external phenomena and the function of the different organs; and secondly, the decomposition of the whole complexity of the external world into its units—briefly the activity of a coupling or synthesizing mechanism and of an analysing mechanism. Through these two activities there are established exact and fine adjustments of the animal organism to the outside world, or, in other words, a complete equilibration of the systems of energy and matter constituting the animal organism with the systems of energy and matter of the environment' [7].

. Generalizing from his observations of animal life, Pavlov states that 'the general characteristic of living substance consists in this, that it responds with its specific activity not only to those external stimulations with which connections have existed from the day of birth, but to many other stimulations, connections with which have developed in the course of the individual's life; or, in other words, that *the living substance possesses the function of adaptability*' [8].

Pavlov, who does not fully grasp the dialectic character of the phenomena which he studies, shows a tendency to drift into generalizations which contain the truth of experimental results, but the error of a mechanistic philosophy. We have seen that Claude Bernard, on realizing the relative constancy of certain physico-chemical factors in the constitution of an organism, fell into the error of supposing that the activities of the organism were devoted primarily to preserving that constancy, thus making an *end* out of what is actually a *part* of life. Pavlov, who has revealed the function of the brain in so far as it enables an organism to analyse its environment and maintain definite but temporary relations with elements of that environment, has mistaken this *aspect* of brain function for the entire fundamental activity of the brain. It is a mechanistic view to reduce the

fundamental activities of the higher part of the central nervous system of man (whom Pavlov does not consistently exclude from his generalizations) to coupling an individual to various elements of an analysed environment. This is equivalent to reducing the brain of man to the level of a telephone switchboard.

Again, Pavlov would have us believe that the behaviour of an individual consists *exclusively* of a series of reflexes, performed in the manner of a machine going through a series of complicated tasks. This mechanistic error arises out of a rejection of mind not only from experimental considerations, but also from far-reaching generalizations drawn from the facts of experiments. It is true that Pavlov does not consistently deny the existence of mind. For example, referring to subjective states, he says: 'Certainly these states for us are a reality of the first order. They give direction to our daily life, they condition the progress of society. . . .' [9]. However, this statement represents merely an isolated move by Pavlov away from mechanism. In the greater part of his theoretical conclusions, Pavlov gives no indication that he realizes that subjective states influence the daily life of individuals and the progress of society, or that reflex actions form but an aspect (fundamental it is true) of human activity.

A lack of understanding of the dialectic is evident throughout Pavlov's writings, for example, regarding 'the basic activities of the higher parts of the central nervous system', through which, it is said, 'there are established exact and fine adjustments of the animal organism to the outside world, or, in other words, a complete equilibration of the systems of energy and matter constituting the animal organism with the systems of energy and matter of the environment'.

The conditions of Pavlov's work are those of an artificially isolated and relatively static environment, in which animals are made more or less passive recipients of selected stimuli, for a limited period of time. Generalizing from observations of animal reactions under such conditions, and lacking a comprehension of dialectic materialism, Pavlov sees only 'adjustments' and 'equilibration' in an organism's relation to its environment. A dialectic materialist, however, perceives not only adjustments and equilibration, but also *struggle* and *change*. The evolution of animal life, and the existence of hereditary characteristics of organisms are part of that struggle and change, which in Pavlov's sweeping generalizations find little or no mention.

Similarly, in describing the general characteristic of 'living substance' as that of 'adaptability' to environment, Pavlov neglects the equally general characteristic of *struggle against environment*.

'Living substance' does not exist as one homogeneous mass, but as individual organisms in vastly different stages of development. The highest stage of development, which man has reached, is characterized by the existence of society, which has lifted man from the beasts, differentiating him qualitatively from all other living things.

Man's social struggle against nature has behind it the evolutionary struggle of lower organisms against their environment. In the process of evolution, 'living substance' did not only adapt itself—it also fought! Man as a social being now struggles with nature, and in that struggle he does not show only adaptability—he shows also the power to adapt nature to suit himself.

If Pavlov falls into certain errors in generalizing from his experimental results, his theory of conditioned reflexes is nevertheless a dialectic conception in so far as he regards the reflexes of the brain as resulting from the interplay of the two processes of excitation and inhibition.

Stimuli of the external world may cause excitation or inhibition of the central nervous system of an animal. From Pavlov's experiments it is apparent that excitation and inhibition may alternate over various parts of the brain, the processes in different areas affecting each other. Stimuli which give rise to temporary, conditioned reflexes Pavlov terms 'temporary agents'. He says: 'It is possible for these temporary agents to produce in the central nervous system the process of inhibition as well as that of excitation. You can readily see that this is of the greatest importance in our life as well as in the life of animals; it amounts to this, that *under any given circumstances and at any moment a certain activity must be manifested, but in another situation, inhibited.*

'*Upon this principle is founded the highest orientations of life.* In such a way a continual and proper balancing of these two processes lays the basis of a normal life for both man and animal. *These two opposite processes, it is necessary to add, are co-existent and equally important in the nervous activity*' [10].

Pavlov considers that the cerebral cortex consists of 'a huge mosaic of points of excitation and of inhibition closely inter-

mingled. . . . This mosaic is formed and reinforced by the reciprocal crowding in of the opposed processes of excitation and inhibition, directly called out by the corresponding external agents; partly, however, by internal relations, in particular, by reciprocal induction, when one process leads to the strengthening of the other" (*Lectures on Conditioned Reflexes*, p. 855).

Referring to the behaviour of human beings (children), Pavlov concludes: "Thus the normal highest nervous activity of the child is founded on the highly flexible balancing between irritation and inhibition."

This emphasis on the existence of two dynamically opposed processes of excitation and inhibition in the brain, forming the basis of the reflexes of the brain, is one of the essential points of Pavlov's theory. A second point is the demonstration that certain reflexes (conditioned reflexes) are temporary, unstable, and acquired during life, in contrast to those reflexes previously known (unconditioned reflexes), which are inborn, permanent and stable.

A third essential point of Pavlov's work is his indication that reflexes are not merely simple, isolated reactions, but are often 'extremely complicated' (e.g. the vomiting reflex and many locomotor reflexes); may possess a 'chain-like character' (i.e. the compounding of a complex effect from simple components, whereby the end of one action is the stimulus for the beginning of another); and are dependent on the 'internal condition' of the organism. Pavlov indicates that any given reflex, as a response to a certain external stimulus, 'is not only governed and regulated by other simultaneous reflex actions, but also by a multitude of internal reflexes, as well as by the presence of many internal stimuli, viz. chemical, thermal, etc., operating in different regions of the central nervous system or even directly in the executive elements (motor or secretory) . . .' [11].

This last widening of our conception of reflex action is described by Pavlov in an attempt to identify reflexes with instincts, which are subjective categories. This mechanistic error is in line with Pavlov's description of consciousness as a 'nervous activity of a certain part of the cerebral hemispheres' (*Lectures on Conditioned Reflexes*, p. 221). Pavlov's philosophical faults do not, of course, remove the fact of his great scientific achievements, which have thrown so much light on the function of the brain.

2. 'BEHAVIOURISM'

While Pavlov may be said to have fallen into errors of a mechanistic nature, J. B. Watson, the author of 'Behaviourism', labours painfully to construct a mechanistic philosophy. Watson denies altogether the existence of mind, and regards man as a machine devoid of thought in the subjective sense. His argument is developed in the following way:

All human *actions* are regarded as reflexes, produced by stimulation of various parts of the body. *Language* consists entirely of reflexes, which form habits of the speaking parts of an individual—lips, tongue, throat muscles, as well as head and face muscles, hands which gesticulate, etc. Language is a 'manipulative habit' [12] of the laryngeal and other muscles.

Memory then becomes reduced to 'the retention of a given habit' [13]. Memory 'is really the functioning of the verbal part of a total habit . . . the running through or the exhibition of the verbal part of a total bodily organization' [14]. According to Watson, when we *remember*, and give the correct answer to a question, all that occurs is that our bodily structure, especially that for speech, responds to the auditory stimulus of the question by a series of reflexes (a habit), which end with our lips, tongue, throat, etc., making certain sounds previously made in connection with a similar auditory stimulus.

Thought is reduced to imperceptible language. According to Watson: 'The behaviourist advances the view that *what the psychologists have hitherto called thought is in short nothing but talking to ourselves!*' [15]. This raises the question: do we only think in words? Watson replies: 'Yes, or in conditioned word substitutes, such as the shrug of the shoulders or other bodily response, found in the eyelids, the muscles of the eye or even in the retina.' [16]. Mind, therefore, is a myth—thinking consists only in the movements of parts of the human machine. 'The term thinking ought to be made to cover generally all implicit language activity and other activity substitutable for language activity' [17]. Watson suggests that thinking 'might become our general term to cover all subvocal behaviour.'

Consciousness Watson regards as the act of naming objects of the universe, that is, as movements of the human machine in the response to the stimuli arising from those objects: 'Being "conscious" is merely a popular or literary phrase descriptive of the act of naming our universe of objects both inside and outside' [18].

It is quite evident that Watson identifies mind with matter, and regards man as a machine devoid of subjective states. He asserts that thought *is* the material processes of the body, especially those concerned with speech. He says: 'We thus plan and think with the whole body. But since, as I pointed out above, the word organization is, when present, probably usually dominant over visceral organization, we can say that "thinking" is largely *subvocal talking*—provided we hasten to add that it can occur without words' [19].

Watson rejects the modern materialist view that objects of the physical world are reflected in mind as images, or copies, by saying: 'I assume, of course, that "images", those ghost-like pictures of objects not present to the senses, have been given up in psychology' [20]. This 'assumption' is of little importance, except in so far as it reveals the mechanistic viewpoint of 'Behaviourism'. The mechanist regards as 'ghost-like' that which he cannot roll about like a cartwheel!

When we come to the behaviourist's interpretation of introspection, we hear particularly plainly the creaking of the machinery whereby a human being is shorn of his subjective life. We are told that introspection is a 'phrase descriptive of the more awkward act of naming tissue changes that are taking place, i.e. movements of muscles, tendons, glandular secretions, respiration, circulation and the like' [21]. This is obviously an absurdity. In the first place, it might be impossible for any people to name any tissue changes that are taking place, and consequently impossible for them to use a phrase descriptive of the more 'awkward' act of naming such tissue changes. In the second place, introspection is not a 'phrase descriptive of the act of naming tissue changes'; it is a mental process which an individual performs. For Watson to deny this is equivalent to his denying the reality of behaviourism, his own theory. Supposing Watson were asked how he came to formulate the theory of behaviourism. He would have to deny the possibility of mentally recalling the ideas which came to him in observing human behaviour, for that would be subjective introspection. No, he would have to commence with an account of his observations, and then describe his own various movements in the course of experimenting, writing, speaking, etc. This, however, would not answer the question, it would merely recount how Watson had reacted in response to certain stimuli. It would merely add the reflexes of Watson to the reflexes of Watson's

experiments! It would not tell us anything about the generalizations from facts, the reasoning, the mental conclusions, or the *theory* of behaviourism, which he had formed.

Watson might reply that these are phrases which do not indicate mental processes, but which are 'descriptive of the act of naming' various tissue changes. Perhaps he would then go into a lengthy description of the various tissue changes alleged to constitute his act of thinking. Our questioner would finally be none the wiser for Watson's account of his own bodily reactions, and would come to the conclusion that the theory of behaviourism did not exist. Watson would no doubt cordially agree, and add that neither do ideas of any kind. For the behaviourist, there exist only objects and machines, habits and reflexes.

In his book, *Psychology from the Standpoint of a Behaviourist* (1929), Watson repeats that thinking 'is an integrated bodily process' (p. 358), and 'largely a verbal process' (p. 365). Thus it is clear that Watson regards *as thought* the bodily processes which a dialectic materialist regards *as resulting in thought*. In short, Watson attempts to prove that matter and mind are *identical*.

This crude one-sided view leads him into a number of absurdities. For example, the question arises: why do we go on living if, as Watson says, we have no consciousness—no subjective realisation—of being alive? Watson's answer is at least logical from his previous arguments. 'We go on living', he says, 'because unconditioned and conditioned negative responses have made it impossible for us under ordinary conditions to reach out and take the necessary positive steps to put an end to our existence!' [22]. The bleak negation of this answer compels him to add: 'I hope some day someone will give us a more positive justification of life' [23].

Watson thus reduces life to a matter of avoiding death by a series of purely mechanical acts on the part of an individual. The primary distinction between different forms of life then becomes the different methods of avoiding death, and the highest form of life must be that which possesses the most perfect method of avoiding death! Life is merely an escape from death! This conclusion is the logical outcome of the arguments of behaviourism. If we have no subjective consciousness, and only go on living because we cannot ordinarily end our lives, then we are no higher in the scale of life than the jelly-like

amoebæ, which can have no consciousness, and are perpetually avoiding death by dividing in two! Watson's crude mechanistic materialism causes him to overlook the development and wider aspects of life, and to fall back on the *end* of life in his ultimate conclusions. Not realizing that life and death are dialectically opposed to one another, he subordinates life to death by reducing life to nothing but a collection of reflexes, which only exists because it cannot destroy itself! Furthermore, the individual, as a mere collection of reflexes, is not mentally conscious of himself, and is therefore no higher than a jellyfish, except in so far as he has a more complicated physical structure. Also, he can have no more control over nature than a block of stone, for he cannot understand nature (having no consciousness), and therefore cannot use the forces of nature for his own ends. He only has one 'end', and that is the avoidance of death—which eventually overtakes him! Such are the absurdities of behaviourism!

A consequence of Watson's interpretation of life is that while man appears to be using the forces of nature for his own purposes, in reality the forces of nature are using man! The behaviourist view is that all man's actions are the result of stimuli from his environment, and that man has no mental consciousness of this—he merely reacts as a machine to various situations, i.e. to 'complex groups of stimuli'. Therefore, while men appear to be consciously using steam, electricity, and other forces of nature for their own purposes, men are really being governed as machines by natural forces, which set up reflexes in a purely mechanical fashion. Man thus appears as a pawn in the hands of fate. Watson, however, talks inconsistently about scientists wanting to control natural phenomena [24].

Dialectic materialism avoids these pitfalls of reactionary fatalism. While it is true that man's material environment determines his activities, consciousness and the advance of knowledge enable man to realize this, and to direct environmental forces for his own ends. Economic conditions determine the development of society, but society now has before it the prospect of a conscious co-operative struggle with the forces of nature for the supremacy of the common interests of mankind. Only the deadly decay of capitalist civilization stands in the way.

The philosophy of behaviourism, as a variety of mechanistic materialism, is of course opposed to subjective idealism. There is, however, an interesting connection between these two op-

posed philosophical standpoints. Both Watson and idealists of the Mach type regard science as a *description*, and not as an explanation of things. Watson says of the behaviourist: 'His sole object is to gather facts about behaviour—verify his data—subject them both to logic and to mathematics (the tools of every scientist)' [25]. There is a similarity between this and the view of the Machian idealist Henri Poincaré, that science is 'the selection of facts' Again, in discussing 'meaning', Watson says: 'Meaning is just one way of telling what an individual is doing' [26]. He also says: 'From the behaviourist's point of view the problem of "meaning" is a pure abstraction. It never arises in the scientific observation of behaviour. We watch what the animal or human being is doing. He "means" what he does' [27]. 'Meaning' is a term with a subjective significance. Watson therefore rejects its ordinary significance and uses it to indicate physical activity. Thus science becomes, not an explanation (for that involves 'meaning' in the subjective sense), but simply a description. This view resembles that of followers of Mach, for example, J. S. Haldane, who held science to be merely a description, and not an explanation. Both for behaviourists and Machian idealists science is merely a description 'for practical purposes'. In the case of the behaviourists the description is of physical objects and events. In the case of the Machian idealists the description is of a sequence of sensations, or perceptions. Dialectic materialists, avoiding both these incorrect formulations, maintain that our ideas are representations of the physical world, and that science explains in so far as it reveals relations of the physical world, isolating cause and effect, and disclosing the connection between the accidental and the necessary.

3. THE ELECTRICAL ACTIVITY OF THE BRAIN

Greatest recent advance in exploring brain activity is electroencephalography. In 1924, Hans Berger of Jena successfully recorded the electrical activity of the human brain, which in certain circumstances undergoes a periodic change of electric potential amounting to some 50 microvolts. Electrodes attached to the shaven scalp permit a recording of this electrical beat, which in the normal waking individual occurs about ten times a second.

First published in 1929, Berger's discovery was greeted with the incredulity not infrequently awarded to those who provide their colleagues with fresh food for thought. By 1934, however, the electrical activity of the brain had been investigated by other workers, notably E. D. Adrian, who suggested that the electrical rhythm of the cerebral cortex was an expression of *uniform* electrical activity on the part of cortical cells, especially those of the visual area.

With eyes closed and the mind at rest, paying no attention to particular stimuli or particular ideas, the cells of the cortex apparently work in unison to produce a joint periodic rise and fall of electric potential, the spontaneous ten-per-second brain rhythm of the conscious state. This rhythm—the alpha rhythm—may be regarded as one aspect of a readiness of the cerebral cortex for attention to particular stimuli or thoughts. Whether this readiness for attention can be translated into the actual process of attention depends on other factors with which we are not concerned here.

When consciousness is focused in the act of attention, especially to a visual pattern of some kind, the alpha rhythm ceases abruptly, Adrian's explanation being that the cells of the cortex no longer beat together in electrical unison, but work in correspondence with the particular pattern of stimuli to which attention is being paid. When attention is directed to some particular object or event of the environment, the configurations and sequences of this phenomenon are recorded electrically by the brain cortex, in accordance with the code-like series of nerve impulses which stream into the brain from the sense-organs concerned. Representing psycho-physiologically an object or event to which attention is directed, the brain cells no longer work together in the spontaneous unison of the alpha rhythm, which therefore disappears in the act of attention.

Attention to a particular temporal pattern of visual stimuli, namely a light flickering at a certain definite rate, causes a corresponding temporal pattern in the electrical activity of cells of the brain cortex. A light flickering 21 times a second, for instance, causes an electrical rhythm of 21 beats per second in the brain of an individual looking at the light. Here the cells of the cortex beat together in unison with the flicker of the light, instead of at the spontaneous ten-per-second rate of the alpha rhythm.

A spatial pattern to which attention is directed visually causes a corresponding spatial pattern in the electrical activity of the cerebral cortex. 'If one looks at a bright cross, the initial event in the brain will be the activation of a more or less cross-shaped area at the back of the occipital lobe' (the visual area of the brain cortex—R.L.W.) . . . 'if one hears a sound a pattern will be reproduced in the temporal lobe corresponding to the areas of vibration in the cochlea. *All the external events of which we are aware are recorded as spatial and temporal patterns of excitation in the sense organs. These patterns are reproduced in the brain with a good deal of editing, omission of detail and heightening of contrast, and it is from them that we reconstruct our external world*' [28] (*our italics*).

Here in the words of a leading physiologist—E. D. Adrian—is striking support of the main principle of modern materialism, namely that through the activity of the brain, the mind reflects objects and events of the physical world as psychological copies, or pictures, or images. The highly sensitive apparatus of the electroencephalograph actually shows some of the brain activity that creates a mental image. Our mental images of objects and events of the physical world are spatio-temporal patterns, the electrical basis of which can now be demonstrated to some extent by means of vacuum tube amplification of brain activity.

The whole vast problem of consciousness is thus open to a new type of investigation, leading towards still greater discoveries. The electrical changes recorded by the electroencephalograph imply the existence of electromagnetic fields arising out of physico-chemical processes in the brain. (As already mentioned, the existence of an electromagnetic field around an organism has been demonstrated by Burr and Northrop.) Possibly, then, the mind may consist of fields, no less physical but infinitely more complex than the field around a magnet. The visual field, for example, may be subjectively a particular kind of physical field—a psycho-physiological field whose spatio-temporal relations correspond to the spatio-temporal relations of the environment which is visualized. Matter organized in the form of a living brain may have the capacity to reproduce in highly specialized physical fields the spatio-temporal relations of its surroundings. Such may be the essence of sensory perception.

If this is so, current controversies concerning mind and matter sink into the shadows of bygone misunderstanding.

Philosophical idealists maintain that mind is not a physical reality at all, being on a superior if not a supernatural plane of existence. Before long, physicists will supply neurophysiologists with still more sensitive apparatus for exploring the electrical activity of the brain. Brain surgeons exposing the human cortex under local anæsthesia for therapeutic purposes will eventually have an opportunity of correlating thoughts revealed by the patient with detailed electrical changes of the brain. Electronics is on the eve of making possible a detailed investigation of the electrical activity of the brain. Vacuum tube amplification and the wonders of electronics may soon close the coffin of classical philosophy, by tracing the way in which thoughts are built up as evanescent systems of spatio-temporal relations, belonging to field structures created by cortical cell activity.

Two American specialists in electroencephalography—Fredrick and Erna Gibbs—wrote of Hans Berger: 'His discovery of the correlation between the electrical activity of the cortex and psychic functions was truly revolutionary—his fame is assured for all time' [29]. Following up Berger's discovery, the American investigators Loomis, Harvey and Hobart [30] traced the correlation between the fading of consciousness in sleep and corresponding changes in the electrical activity of the brain cortex. Other investigators, notably the Gibbs, showed that the sudden cessation of consciousness in a major epileptic fit is correlated with a dysrhythmic upsurge in the electric potential of the brain.

Chemists also are beginning to discover for themselves the principles of dialectic materialism. In his address to the British Association in 1934, the well known biochemist J. H. Quastel said: 'Experience is surely showing us that there is a close and intimate relationship between the workings of the mind and the chemical and physical events which proceed in the body' [31].

Quastel's statement was partly based on his own work in connection with mental disorder, origins of which are being traced to disordered physico-chemical processes of the brain. In cases of mental disorder, 'the difficulty appears to be that the cells of the psychotic patient's brain cannot utilize the oxygen' [32]. Oxygen is available, but apparently cannot be fully utilized in the combustion of terminal products of carbohydrate metabolism.

That interference with brain oxidation processes can impair

the mind is shown by effects of high altitudes where the oxygen pressure is markedly reduced. At heights of 12,000 to 24,000 feet, 'higher mental processes are impaired with the loss of memory and attention and yet awareness of what is going on persists. . . . Irrational or fixed ideas are frequent, and capacity for sane judgment and self-criticism is lost. The subject is frequently unaware of his profoundly altered behaviour. . . . Not only are sensory and motor defects brought about, but frequently neurotic and emotional tendencies are unmasked, as with alcohol or hypnosis. . . .' [33].

How the emotions and personality depend upon brain structure has been shown by the effects of prefrontal leucotomy. In this operation, introduced by the Portuguese surgeon Egas Moniz in 1935, nerve fibres between the frontal lobes of the brain and the thalamus are severed. The operation has been performed on mentally unbalanced individuals showing marked fear, anxiety and aggressive tendencies. The effect of the operation in most cases is a striking change in the personality, patients subsequently becoming mentally relaxed and carefree. While the operation—which is not without its dangers—is not undertaken lightly by responsible surgeons, it demonstrates the dependence of the mind upon the structure of the brain. So clearly does this dependence emerge from recent research, we now find scientists stating publicly without reserve the main principle of modern materialism. America's foremost authority on the physiology of the nervous system, Professor J. F. Fulton, has written: '*there is little doubt in the mind of any neurophysiologist that mental phenomena represent some feature of the organization of nerve cells*' [34].

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Chapter IX

LAWS OF NATURE

1. CONCEPTIONS OF NATURAL LAW

IN the statements and theories of science, laws of nature are formulated. Science does not only observe, record and collect facts, but also relates facts to one another in a logical manner. When a relationship of the physical world is sufficiently defined as a result of scientific investigation, it is formulated as a law. The laws of the movements of the planets, of diffusion of gases, of chemical action, of heredity, of evolution, etc., have been derived from the assembly and correlation of large numbers of scientific observations.

In comprehending the connections of events of nature, through the formulation and application of scientific laws, we perceive cause and effect. Relations between events of nature constitute that which we extract as cause and effect. 'The cause of the thing is its relation' [1], said Joseph Dietzgen.

Taking the case of a natural phenomenon, for example, the evaporation of water, we isolate in thought certain relationships in nature, and in simplifying the relationships we arrive at cause and effect. 'Cause and effect', wrote Engels, 'are concepts which can only realize themselves in relation to a particular case. However, when we come to examine the separate case in its general relation to the world at large they come together and dissolve themselves in face of the working out of the universal problem, for, here, cause and effect change places; what was at one time and place effect, becomes cause, and *vice versa*' [2].

To this Lenin adds: 'Hence the human conception of cause and effect always somewhat simplifies the objective connection of phenomena of nature, reflecting it only approximately, artificially isolating one side or other of the world process. . . ' [3]. Likewise, our conception of natural law is relative and limited in being 'partial, incomplete, approximate'. Lenin describes the conception of law as 'merely a stage in the human understanding of the unity and connection, the mutual dependence and uniformity of the world process'.

Materialism regards our conceptions of natural law as representations of the inner nature and connections of phenomena of the physical world. Laws may be expressed in mathematical or in verbal form, but in any case the expressions are human conceptions of what occurs in nature—of relationships as objective as the furniture we use or the food we eat. Our conception of law is derived from objective relations of the physical world, existing independently of human thought. Materialism regards law, necessity, cause and effect as aspects of the manifold relations of the physical world.

In contrast to the materialist view, idealism regards law, necessity, cause and effect as mental in character, having no independent existence apart from human thought.

Let us see what were the views of the idealist Ernst Mach on this question. In Mach's *Science of Mechanics* we read: 'There is no cause nor effect in nature; nature has but an individual existence; nature simply *is*' [4]. Nature, for Mach, is not an objective reality existing independently of human sensations, but consists of 'elements' or sensations. It is therefore with consistency that law, necessity, cause and effect are presented as mental. 'Cause and effect', wrote Mach, 'are things of thought, having an economical office' [5]. The existence of physical necessity is denied: 'Besides logical necessity, there is no other necessity, no physical necessity, for example' [6]. Mach proclaimed his adherence to Hume's treatment of the problem of causality, and defined a law of nature as a 'limitation of expectancy' [7]. This subjective view was also held by Avenarius, another idealist, who wrote: 'Necessity remains as the degree of probability of expectation of effects' [8].

Compare this subjective interpretation with the similar views of the British idealist, Karl Pearson, who said: 'Law in the scientific sense only describes in mental shorthand the sequences of our perceptions' [9]. The following passage from Pearson's *Grammar of Science* is typical of a prevailing point of view among later writers:—

'The law discovered by science introduces no element of necessity into the sequence of our sense impressions; it merely gives a concise statement of *how* changes are taking place. That a certain sequence has occurred and recurred in the past is a matter of experience to which we give expression in the concept causation; that it will continue to recur in the future is a matter of belief to which we give expression in the concept *probability*.

Science in no case can demonstrate any inherent necessity in a sequence, nor prove with absolute certainty that it must be repeated. Science for the past is a description, for the future a belief; it is not, and never has been, an explanation, if by this word is meant that science shows the *necessity* of any sequence of perceptions' [10].

Thus the necessity of a sequence of events in nature is replaced by the probability of a sequence of perceptions. Scientific *explanations* of necessary physical phenomena are denied, and idealism admits only *descriptions* of mental perceptions. The laws of nature are said by Pearson to exist only in the human mind: 'Law in the scientific sense is thus essentially a product of the human mind and has no meaning apart from man. It owes its existence to the creative power of his intellect' [11]. Hence, the order of nature becomes an idea of the individual observer. This is the view that Pearson 'suggests': 'The whole of ordered nature is thus seen as the product of one mind the only mind with which we are acquainted' [12].

Pearson's idealist opinion is a straightforward one, the laws of nature being consistently classed as mental products, together with matter in general. His position is that of solipsism—of Bishop Berkeley—and he does not disguise the fact. Other writers, however, are less candid.

Bertrand Russell, for instance, discusses natural law and causality from a position which, he says, 'as regards scientific law has more affinity with materialism than with idealism' [13]. In truth, Russell's position is idealism, coloured with equivocal statements.

We are told that it is 'at least a tenable hypothesis that all matter is governed by very simple laws' [14]. One would be very simple indeed to take this 'tenable hypothesis' seriously. All matter *is* governed by laws, whose qualities, limitations and connections are not to be crudely summed up as 'very simple'. Russell, in labouring over a false distinction between 'simple' and 'complicated' laws, obscures the essential character of laws in general. He follows this up with the following equivocal statement:—

'Science must continue to postulate laws, since it is co-extensive with the domain of natural law. But it need not assume that there are laws everywhere; it need *only* assume, what is evident since it is a tautology, that there are laws wherever there is science' [15].

If science is to assume *only* that there are laws wherever there is science, then laws are not admitted to exist apart from scientific knowledge, which consists of *mental* representations of physical reality. To suggest that there are not laws everywhere, but only where there is science, is to follow Mach, Pearson and other idealists, who assert that natural laws do not exist apart from mind. Russell's 'tautology' thus becomes an identification of laws of nature with conceptions of science—and so of matter with mind. From this identification proceed the arguments of subjective idealism in one direction, and of mechanism in an opposite direction. Russell, with many evasive turns, takes the path of subjective idealism.

Russell's treatment of causality is similarly equivocal, concluding with a rejection of universal causality. He says: 'The world of physics is intended to be a causally interconnected world, and it must be such if it is not to be a groundless fairy tale, since our inferences depend upon causal laws. Therefore if anything occurs which is causally isolated, we cannot include it in physics. *We have no ground whatever for saying that nothing is causally isolated. . . .*' [16]. Russell calls himself a monist, yet he implies that something may occur which is causally isolated, that is, which is independent of the rest of the universe! In abandoning monism, he opens the door to spiritualists and mystics, who can claim that their fantasies are real, but are 'causally isolated', and thus beyond science. He adds: 'but we can never have ground for saying: such-and-such a causally isolated event exists'. This poor equivocation would assure that 'we' are not trapped in a denial of causality, but that spiritualism and mysticism are allowed a place beside scientific theory, for 'we have no ground whatever for saying that nothing is causally isolated'!

2. DYNAMIC AND STATISTICAL LAWS

Modern physics distinguishes between two kinds of natural laws—'primary' or dynamic and 'secondary' or statistical laws. Dynamic laws are laws of the particular, expressing individual relationships; for example, of moving bodies such as a pendulum, or a spinning top. Statistical laws, on the other hand, are laws of the general, expressing relationships resulting from the mutual interaction of the individual elements of a whole. For

example, properties of a gas are stated in terms of statistical laws, expressing the outcome of the mutual interaction of the molecules constituting the gas.

The qualities of a whole (for example, a gas) are not merely the sum of the qualities of its individual elements (molecules of the gas). Dialectic materialism recognizes that the mutual interaction of the elements of a whole produces a result (the whole), which possesses its own qualitative peculiarities. To take an example from biology, a cancerous growth consists of a collection of individual elements (cells), but the qualities of the growth are more than the sum total of the qualities of its individual cells. The laws of development and action of a growth are qualitatively distinct from the laws governing its individual cells.

Again, an epidemic of a disease is more than the sum total of the elements of the epidemic. For example, in an epidemic of smallpox, factors (elements) present include the organisms of the disease, the resistance to disease of the population, the living conditions of the population, the medical attention available, etc. Each of these elements has its own unique aspects and peculiarities, for example, a quantitative or qualitative modification of the organisms concerned, the effect of vaccination or disease on the population, the class content of the living conditions, the degree of skill and equipment of the medical attention available.

An epidemic itself, however, is more than the sum total of all its elements. An epidemic is subject to specific laws, which are open to investigation by statistical methods. The quantitative and qualitative aspects of epidemics are the subject of a special study—epidemiology, which is not merely the collection of facts of other sciences—biology, pathology, sociology, etc., but the treatment of all relevant facts by specific methods—including statistical means.

Statistics, however, cannot exhaust the analysis of an epidemic, which depends on every one of its elements, each of which, having its own peculiar qualities, is open to investigation only by the appropriate methods, e.g. of biology, pathology, sociology (including again statistical means).

The science of epidemiology, therefore, which investigates laws of the general—statistical laws of epidemics—comprehends also the existence of those laws of the particular with which the laws of the general are united, namely, those of toxic action, reaction to infection, economic development, etc.

The connection between necessity and probability can here be illustrated in our example. The probabilities of the course of an epidemic are seen to be connected with the necessary progression of the various factors of the epidemic. We do not deny the existence of necessity in an epidemic just because statistical methods give us probabilities concerning the course of the epidemic. On the other hand, we do not assert that the probabilities arrived at by epidemiologists exist only in their own minds, without any counterpart in the relationships of the physical world.

Naturally, estimations of probability, in epidemiology as in every science, are dependent upon the data available. The more complete the data known to scientists, the nearer can statistical results approach to objective reality. In extracting laws of nature from the facts of scientific observation, we do not obtain exact representations of physical relationships. The formulations of science, whether of dynamic or statistical laws, partake of the relative character of knowledge. As science advances, our knowledge of natural law approaches more closely to the realities of the physical world. At one point of the advance it is dynamic law which science reveals, at another point it is statistical law.

Mechanists sometimes assert that ultimately dynamic law will entirely replace statistical law in science. This is equivalent to stating that one day we shall know everything. If no laws of the general were required by science, it would mean that all laws of the particular were known—every causal relation of every particle of matter—every molecule, atom and electron! This metaphysical assumption of the possibility of absolute knowledge is one aspect of the mechanist outlook, which fails to realize also the objective existence of laws of the general.

Dialectic materialism shows that dynamic and statistical laws are intertwined in the world process, which is revealed by science now in its general, now in its particular relationships. Dynamic and statistical laws exist in nature *together*, in contradictory unity. The metaphysical separation of these laws by idealists on the one hand, and by mechanists on the other, is at the basis of the confusion in modern physics. This confusion is not avoided by the eclectics, who make a pattern out of the errors of both mechanism and idealism. Only dialectic materialism is capable of solving the fundamental problems of the present crisis in science.

Both mechanists and idealists fall into the error of *separating*

dynamic and statistical laws in an anti-dialectical manner. It is not realized that laws of the particular and laws of the general are dialectically united in every phenomenon of nature.

Following upon discoveries of heat conduction, atomic structure and radiation, physicists have emphasized the universality of statistical laws. Molecular and sub-atomic processes are known to follow statistical laws, while dynamic laws of individual atoms and molecules remain unknown. Atomic physics has demonstrated the existence of individual molecules and electrons, but not always the laws governing their individual movement. At the same time, statistical laws have been formulated which account for phenomena resulting from the movement of large numbers of molecules and electrons.

This situation has been seized upon by idealists who assert that *only* statistical laws exist for atomic entities, which are alleged to move only by 'pure chance'. Certain writers, for example Professor Eddington, have gone so far as to attribute 'free will' to electrons, and indeed to all bodies, astronomical as well as atomic. The electron is said to 'jump when it likes'; the earth likewise 'goes everywhere it pleases'!

This point of view expresses *indeterminism*—the doctrine that all things happen, not according to law, but according to 'chance'. Thus the cause and effect of deterministic science becomes replaced by a series of 'probabilities'. Universal causality is denied by idealists, who regard the universe as a chaos, yielding only certain statistical results.

This argument of idealism denies that there are laws of the particular. Only laws of the general are said to exist, and—according to other idealist arguments—these laws of the general exist only in thought, as human estimations, without independent physical reality.

If there are no laws of the particular—no dynamic laws—but only laws of the general, which permit exceptions, then nothing is impossible. A world of chaos, the events of which occur only by 'chance', is a world where anything may happen. No limits are granted to statistical laws, when their connection with the particular qualities and essential relations of events is denied.

Dialectic materialism, in its monistic interpretation of the universe, excludes the conception of a world of chaos, where 'anything' may happen. Idealists, who reduce all dynamic laws to statistical probabilities, deny the existence of universal causality, and the universal application of deterministic law.

Thereby the wildest fancies become realizable, and miracles are provided with a 'scientific foundation'. For example, according to Eddington, 'if an army of monkeys were strumming on typewriters they *might* write all the books in the British Museum'. According to Bertrand Russell: 'if you drop one drop of ink into a glass of clear water it will gradually diffuse itself throughout the glass. It might happen by chance that it would afterwards collect itself again into a drop but we should certainly regard it as a miracle if this happened' (*The Scientific Outlook*, p. 94).

Statistics used in this way becomes a game with figures, devoid of scientific value. Laws of the general are rendered fictitious *by denying them any limits, or their connection with laws of the particular*. Probability is reduced to a farce. The scientist with the wildest imagination wins the prize for statistical 'prediction'. To such a state of formal absurdity do idealists degrade the conception of natural law, ignoring or distorting the inner connections and essential aspects of natural processes.

At the opposite pole to idealism are the mechanists, whose crude, anti-dialectical materialism is a barrier to a solution of the contradictions facing scientific theory. The mechanists regard statistical law as merely a substitute for our ignorance of dynamic laws. Statistical laws are alleged not to exist in nature, being merely reflections of our ignorance of dynamic laws.

This interpretation of laws of the general makes no qualitative distinction between our conceptions of laws of the general and laws of the particular. It is said that every general movement is merely the sum total of the (mechanical) movement of its individual elements. Thus a social movement is only the sum total of the actions of the individuals of society. The actions of an individual are only the sum total of his bodily movements, which in turn are only the sum total of the movements of molecules. And molecular movement is only the transposition in space of electrons. . . . *Thus quality vanishes in the final reduction of everything to positive and negative electricity*. A whole is therefore merely the sum of its parts. The behaviour of a gas, for example, is regarded as merely the sum total of the behaviour of the individual molecules of the gas. No qualitative peculiarity is attributed to the gas as a whole. No objective existence is admitted for the laws of the general to which the gas as a whole is subject. These statistical laws are thus considered merely

convenient subjective conclusions—substitutes for our ignorance of the objective laws of the particular governing the individual molecules of the gas.

This mechanistic view excludes recognition of the transition from quantity to quality occurring everywhere in nature. Dialectic materialism recognizes that quantitative change, in accumulating, becomes qualitative change. To revert to our example of an epidemic of disease, various quantitative changes may occur, e.g. organisms of the disease may increase in number, the moisture of the atmosphere may increase in amount, the number of people afflicted with the disease increase. All these quantitative changes (along with other changes) may produce a result with its own qualitative features, namely the epidemic itself. For a mechanist, however, all the qualitative features of the epidemic are merely so many aspects of quantitative change, reducible ultimately to the mechanical transposition in space of atomic particles.

Any whole, however, is more than the sum of its parts. A tennis ball, for example, is more than the quantitative addition of rubber, air and fabric. A painting is more than the mathematical sum of different pigments. Rembrandt's 'Night Watch', for example, is more than the amount of colouring materials and canvas used in its production. With the inner relations of any whole, quality appears, distinct from the quantitative aspects of the whole. The world is not a mere collection of mathematical units. Quantitative analysis by itself can never exhaust the content of anything.

In the endless qualitative and quantitative features of the universe, in the infinite shades, patterns, configurations and relations of the physical world, dialectic materialism reveals contradictory elements and processes, from which our conception of the contradictory unity of laws of the general and laws of the particular is derived.

Matter, which is primary to mind, thus yields the secrets of its contradictions to mental effort. Mind, which is derived from matter, reflects its contradictory nature. Human thought, in comprehending the contradictory nature of all things, and in recognizing the reign of law, leaps 'from the realm of necessity into that of freedom'.

Chapter X

THE CRISIS IN MODERN PHYSICS

1. EXPERIENCE

MODERN physics is a battleground. On one side mounts an ever increasing array of facts supporting dialectic materialism. On the other side manœuvre writers whose opposition to materialism is tempered by anxiety to avoid a pitched battle. For these Fabians of physics, positivist philosophy is now a favourite doctrine. Writing as a materialist, a leading physicist has given us a glumpe of the scene. Referring to the conceptual world of science as 'the physical world', Max Planck says:

'Is the physical world' (i.e. the world of scientific knowledge) 'simply a more or less arbitrary creation of the intellect, *or are we forced to the opposite conclusion that it reflects phenomena which are real and quite independent of us?* Expressed in a more concrete form, can we rationally assert that the principle of energy was true, even when nobody could think about it, or that the heavenly bodies will move according to the law of gravitation, when our earth and all that is therein is in ruins? If, looking back over the past, I give an affirmative answer to these questions, I am certain that this answer is, in a way, contradictory to a tendency of natural philosophy (recently introduced by Ernst Mach) which is in great favour in scientific circles. According to this nothing is real except the perceptions, and all natural science is ultimately an economic adaptation of our ideas to our perceptions, to which we are driven by the fight for existence' [1] (*our italics*).

Mach, whose pseudo-science was thoroughly exposed by Lenin in *Materialism and Empirio-criticism*, has his positivist successors who likewise preach a disguised form of philosophical idealism. In Britain, the most vocal positivist in scientific circles is Herbert Dingle, formerly professor of physics at the Imperial College of Science. In America, positivist ideas are propounded by P. W. Bridgman, R. B. Lindsay, H. Margenau and others under the high-sounding title of 'operational technique'.

Positivists, like other philosophical idealists, deny that the physical world exists independently of human experience. All

knowledge is said to be experience set in order by reason. What experience is, and whence reason is derived, are questions which positivists consign to religion or metaphysics. Science is concerned merely with experience, not with questions of physical reality—with this sweeping generalisation, our positivists retire backwards like hermit crabs into impenetrable shells of mathematical symbolism.

Two meanings of the term *experience* are confused by writers who seek to render science compatible with religion. As used in everyday language, whether in the laboratory or in the street, the word means an individual's sensory experience of his external physical environment. We learn about the physical world around us by its effects on our sense-organs and central nervous system, these effects giving rise to sensory perception. This sensory experience consists of psycho-physiological processes whereby we perceive objects and events which exist independently of perception. This is the kind of experience whereby scientific knowledge is acquired through systematic study of the physical world. To quote two nineteenth century physicists, William Thomson and P. G. Tait: 'By the term experience in physical science we designate, according to a suggestion of Herschel's, our means of becoming acquainted with the material universe and the laws which regulate it' [2].

Experience of an actual earthquake, for example, is a sensory experience. The earth vibrations that give this experience to anyone in the vicinity do not depend upon any human being. The earthquake that gives individuals present this particular experience is quite independent of their perceptions, consciousness and lives.

Very different is the experience of dreaming about a non-existent earthquake, or having hallucinations that earth tremors are occurring. This purely subjective experience of one particular individual is a psycho-physiological process, but not a sensory perception of an actual earthquake. Experience of this kind, which includes religious experience, does not reflect physical reality. The human mind can create imaginary ideas that do not represent actual physical phenomena. Arising with or without conscious volition, these imaginary ideas depend upon the state of mind of the individual concerned, not upon a corresponding physical reality of the external environment.

Positivists profess to see no essential difference between sensory experience and imaginary experience. Physicists who

advance positivist arguments know little or nothing about the physiological processes of sensory perception, or about psychological processes of the imagination. As a result, they are found embracing a confusion which is completely ludicrous in the light of other sciences. Denying the existence of physical reality independent of human thought, positivists claim that all experience is purely subjective, thus obscuring the essential difference between sensory perceptions and figments of the imagination. The delusions of a lunatic, the pictorial fancies of an artist, the 'revelations' of a mystic and the observations of a scientist are all muddled together in the one category of 'experience'. As Planck has pointed out, 'in positivist physics . . . there is no such thing as delusion in sensuous perception' [3].

According to Dingle, experience is merely the 'aggregate of sensations and feelings' [4] which a scientist endeavours to 'rationalize'. Physicists, he maintains, thus 'create' the material which they study. 'An electron is the product of 300 years of unwitting mental creation'! [5]. 'We are bound to recognize', he writes, 'that our activities, in theoretical physics at least, are not so much those of discoverers of unknown lands as those of creators of works of art. We do not look for the "reality" behind experience but seek to create a language in which the relations between our experiences can be most comprehensively and elegantly expressed'. [5]. Dingle here joins hands with the logical-positivists, who attempt to reduce all theoretical problems to questions of 'language'. Doyen of the logical-positivists is Wittgenstein, who has been frank enough to say that his own propositions are meaningless [6].

The same kind of rubbish comes from Lindsay and Margenau in their *Foundations of Physics*. There we learn that 'physics has nothing to say about a possible real world lying behind experience . . . One often hears the statement that the task of physics is to describe or explain the behaviour of the material world. We cannot help feeling that this is meant to imply the existence of such a world . . . ' [7]. This shocking materialist implication is what Lindsay and Margenau hope to see rooted out of the foundations of physics.

P. W. Bridgman, another physicist with a philosophical axe to grind, is quite satisfied that nothing exists except in his own thoughts. In his *Nature of Physical Theory*, Bridgman writes. 'I can never get outside of myself; direct experience embraces only the things of my consciousness. . . . In the last analysis

science is only my private science, art is my private art, religion my private religion, etc. . . . If I say that an external thing is merely a part of my direct experience to which I find you react in certain ways, what more is there to be said, or indeed what other operational meaning can be attached to the concept of an external thing? It seems to me that as I have stated it, the solipsist position, if indeed this be the solipsist position, is a simple statement of what direct observation gives me, and we have got to adjust our thinking so that it will not seem repugnant' [8].

While on the one hand they are quite certain that nothing can be held to exist independently of human thought, scientists with Bridgman's outlook contend illogically on the other hand that questions of existence are outside the scope of science. The scientific worker, says the American physicist Irving Langmuir, 'is not often concerned with questions of existence, he does not know the meaning of the question, "Does an atom really exist"? . . . we cannot be sure just what we mean even by the word "exist"? Such questions are largely metaphysical and in general do not interest the man of science' [9].

Langmuir's fine assumption of indifference to the existence of atoms no doubt excludes uranium. In the vicinity of an atomic bomb about to explode, neither he nor any other scientist is likely to doubt the existence of uranium atoms independent of human thought. When it comes to practice, physicists are apt to forget any positivist doctrines they may have acquired through 'experience'. Any scientist who attempts to appropriate a colleague's apparatus on the grounds that it exists only in his own mind is liable to suffer a rude shock.

While Langmuir and his fellow positivists profess to have no interest in questions of existence, they nevertheless use much ink in disputing the materialist conclusion that scientific thought reflects an independently existing physical reality. This involves an attack on the concept of truth, since truth in science is essentially a correspondence between ideas and physical reality. According to the 'latest' fashion in pseudo-scientific thought, truth is just a set of practical propositions that serves a particular purpose. Truth is just a pair of spectacles, according to positivists who claim to *create* the physical world through rationalizing their own 'experience'. From this point of view, truth in the commonly accepted materialist sense of the word is a fallacy. 'The word is superfluous' [10], says Professor Dingle,

who asks blandly: 'What can truth be when we are free to *make* the world we thought we had truly to *describe*? And what is knowledge when we can at will destroy the objects known?' [11] (*our italics*).

Maintaining that physicists *create* in their own minds the objects and events which they deal with mathematically, Dingle tells us that 'an electron is the product of 800 years of unwitting mental creation' [12]. Hence there can be no sense in the statement that it is impossible to know simultaneously and exactly the position and momentum of an electron, for an electron is merely a mental creation, not an independently existing particle! 'From our point of view', declares Dingle, 'this statement is seen to be meaningless. An electron is a postulate, and a postulate is not a thing to which the term knowledge applies. . . .' [13].

Positivist philosophy is thus sheer escapism as far as fundamental theoretical questions of physics are concerned. While some of the conclusions drawn from Heisenberg's principle of indeterminacy cannot be justified, the principle itself is a generally accepted formulation which leads towards further progress in scientific theory. Especially in directing attention to the general concept of position and change of position does Heisenberg's principle promote further advances.

Professor Dingle would have us believe that in physics an idea is true when it becomes a 'memory' in the mind of an individual physicist. 'To say that a hypothesis is true is to say that it has become a memory' [14]. Everything, you see, is 'experience', and what sticks in the mind as memory is 'true experience'. And presumably, what becomes a memory in science has nothing to do with those outside the magic circle of memorizing experts!

Positivists will permit us to think a little differently about the truth they so readily sacrifice upon the altar of 'pure science'. The memory of Professor Dingle or any other individual is no substitute for the truth which inspires so much human effort. Science is a systematic search for truth, the finding of which gives power for good or ill to those who control the instruments of science. Scientific truth is a definite though approximate correspondence between formulated ideas and physical reality, a correspondence that stimulates and steadies scientific effort.

In contrast to positivist doctrines, there is the materialist standpoint taken up by other physicists. Einstein, Rosen and

Podolsky, for example, writing in the *Physical Review*, express their materialist outlook as follows: 'Any serious consideration of a physical theory must take into account the distinction between the objective reality, which is independent of any theory, and the physical concepts with which the theory operates. These concepts are intended to correspond with the objective reality, and by means of these concepts we picture this reality to ourselves . . . the correctness of the theory is judged by the degree of agreement between the conclusions of the theory and human experience. This experience . . . in physics takes the form of experiment and measurement' [15].

No less definite is the following materialist statement by the astronomer de Sitter, who writes: 'Physical science, like common sense, takes for granted that there *is* reality behind the phenomena,* which is independent of the person by whom and the particular methods by which it is observed . . . the physicist unhesitatingly believes that his laws are general, and that the phenomena continue to happen according to them when nobody is looking . . . to all intents and purposes the laws *are* the reality, if we eliminate from them all that refers to the observer alone' [16].

In order to avoid discussion leading to such general materialist conclusions, positivists propose that theoretical statements should be confined to *particular* observations and experimental operations. This is Bridgman's 'operational' approach to physics, and it has been criticized as follows by Max Born, a physicist whose work is closely concerned with phenomena that cannot be adequately described in terms of the particular. Born writes:

'It is reasonable to introduce temperature by describing the thermometric operations, or to define the electric field by referring to the forces on small charged test bodies. But the operational definition is rather out of place if you wish to extend the idea of the field to atomic nuclei and electrons and it comes to grief in quantum theory. Wave mechanics has a catalogue of "observables". But that does not mean that the corresponding quantities are represented by variables whose values could be measured; they are represented by differential or integral operators whose eigenvalues can be measured. I cannot see what experimental "operation" could be devised in order to define a

*de Sitter makes a Kantian distinction between phenomena and reality which does not alter the materialist character of his statement. Observed reality *consists* of phenomena acting upon our sense-organs and giving rise to ideas corresponding with the phenomena observed.

mathematical operator. Moreover I have already mentioned that there are concepts used in wave mechanics which are not observables, for instance, Schrödinger's wave function; there are in principle no means to observe it, hence no "operational" definition' [17].

Wave mechanics is a mathematical way of describing phenomena that enter into human experience collectively. The behaviour of a particular solid body depends upon a collective interaction of its constituent particles and fields—an interaction studied chiefly by the science of crystallography. The behaviour of any particular particle depends upon the collective interaction of wave processes which are studied statistically. In these wave processes we encounter general modes of existence of matter in highly unfamiliar forms, demanding new concepts and new mathematical methods for their quantitative analysis. Working with these new concepts and methods, mathematicians are producing a picture of physical reality which is fatally disturbing to mechanistic ideas of matter and motion. It is no longer possible to reconcile nineteenth century generalizations concerning matter with the twentieth century analyses of wave mechanics. Hence the confused and contradictory interpretations of scientific discovery by individual scientists, some of whom look longingly towards a purely empirical standpoint, while others such as Milne float fantastically on elegant assumptions derived from wholly imaginary 'observers'. What is most needed are new generalizations concerning matter and motion, based upon relativity theory and wave mechanics. Such generalizations, however, would greatly strengthen materialism by getting rid of obsolete mechanistic ideas about matter and motion, and by confirming principles of *dialectic* materialism. Still delayed, therefore, is a radical revision in theoretical physics of fundamental premisses concerning matter and motion. On fundamental questions, positivism provides a ready means of escape from materialist conclusions by way of the ambiguous term *experience*.

2. MATTER AND ENERGY

ACCORDING to current theoretical physics, matter does not comprise all that exists independently of thought. On the contrary, matter is arbitrarily defined as that which consists of

discrete particles—protons, neutrons, electrons, etc. The rest of the physical universe is held to consist of gravitational, electric, magnetic and perhaps other fields—sometimes described obtusely as ‘empty space’. This *a priori* assumption concerning the nature of matter is derived historically from the atomism of ancient Greek philosophy, which in the 16th and 17th centuries was used by Galileo, Gilbert, Boyle, Newton, Descartes and other scientists to sweep away the cobwebs of Aristotelian dogma. Developed in the 19th century through Dalton’s atomic theory and the kinetic theory of gases, the particle theory of matter underwent profound changes in the course of its evolution, while nevertheless retaining the premiss that material particles and empty space (filled perhaps with an ethereal ‘medium’) form the sum total of physical reality. Meanwhile, however, a separate branch of physics was growing up as a rival to purely particle theories of physical phenomena.

Side by side with the development of modern atomic theory, field physics proceeded more or less independently from the discoveries of Faraday and Weber and the mathematics of Clerk Maxwell. The genius of these three men eventually forced upon physics the realisation that physical fields—invisible and intangible—are every bit as real as any particle of matter.

The gravitational field, Einstein has written, ‘must be looked upon as real’ [18]. When such a field is created by a rotating body, as in the case of a fast-spinning flywheel, the field is likewise ‘physically real’ [19] (Weyl), and may even break the wheel which creates it. As for the electromagnetic field, it is for the modern physicist ‘as real as the chair on which he sits’ [20]. Since Maxwell’s time, ‘physical reality has been thought of as represented by continuous fields, governed by partial differential equations, and not capable of any mechanical interpretation’ [21].

Field physics was forced to develop its own more or less separate theory, ignoring the prevailing assumption that physical reality consists only of particles and empty space. Thus arose not one physics but two—the field physics of Faraday, Maxwell and later Einstein, the laws of which do not conform to those of mechanics; and on the other hand the particle physics of classical theory, attempting to fit all physical phenomena into the logical framework of mechanics. Physicists are only too familiar with the difficulties and contradictions still arising out of this particle-field dualism.

For a time, the ether hypothesis bridged the gap between classical mechanics and the wave theory of light originally established by Young and Fresnel. It was inconceivable that between the separate particles of discrete matter there could be mere emptiness, for how in that case could light waves be transmitted between material particles at a distance from one another! The knotty problem of 'action at a distance' was insoluble without the hypothesis of a physical medium between distant material bodies—a medium capable of transmitting the electromagnetic waves of light. Hence the concept of a physically real yet non-material ether, permeating the universe by filling all space.

For a time, the ether was the answer to a physicist's prayer for an explanation of electromagnetic phenomena. But because nineteenth century physicists held in the main a mechanistic view of nature, they visualised this hypothetical ether as obeying ultimately the laws of mechanics. All was well until mathematical efforts were made to fit the mechanically conceived ether into the logical framework of classical mechanics. All such mathematical efforts were unsuccessful. No one was able to reconcile the contradictory properties of the ether in mechanical terms. The contradictions arising out of the hypothesis of a mechanical ether have been described as follows by L. Rougier:—

'To fulfil its office the ether must accumulate the mutually exclusive properties of solids and fluids. It must behave like an elastic solid, endowed with a rigidity surpassing that of steel in order to transmit nearly instantaneously the transverse vibrations of light; it must behave like a fluid with a density much less than that of the lightest gas, in order not to retard the translatory motion of the stars, and not to rob them of their atmosphere; but in the neighbourhood of the electrons it must have a density far surpassing that of lead. All this is incomprehensible, and no one can, under the plea of thinking in terms of the ether, evade thinking according to the law of contradiction.

'If the ether exists, it is incapable of motion, as is proved by the impossibility of reconciling Fizeau's experiment with Hertz's hypothesis of a complete entrainment of the ether by matter in motion, and the impossibility of reconciling the principle of action and reaction with Fresnel's and Fizeau's hypothesis of a partial entrainment of the ether. But, if the ether is incapable of motion, our laboratories and our instru-

ments are continuously traversed by an ether current, the velocity of which is equal and opposite to that of the earth and varies as a function of it. Such a current would exert a considerable influence on electromagnetic and optical phenomena. Now the experiments undertaken to show the absolute motion of the earth with respect to the ether, with which a privileged set of reference axes might be connected, show that there is none. The hypothesis of an immovable ether is in its turn contradicted by the relativity principle' [22].

Relativity theory excluded the idea of an ether filling space and acting as a medium for the transmission of electromagnetic radiation. When it became clear that the ether could be neither at rest nor in mechanical motion, the whole ether hypothesis was finally discarded. The mechanistic tradition of physics excluded the possibility of a physical medium that was not in any mechanical state, either of rest or of motion.

What then was to be regarded as the physical basis of electromagnetic radiation? What transmitted light from one body to another? Within the limits of their main assumptions, physicists could only declare that space itself 'has the physical property of transmitting electromagnetic waves.' [23]. Einstein at one time suggested that space with the physical property of transmitting light might legitimately be termed an ethereal medium or ether, provided one did not retain the former idea of an independent empty space *containing* an ether. He wrote: 'According to the general theory of relativity, space is endowed with physical qualities; in this sense, therefore, there exists an ether. . . . But this ether may not be thought as endowed with the quality of ponderable media, as consisting of parts which may be tracked through time. The idea of motion may not be applied to it' [24]. The majority of physicists, however, refused to follow Einstein in his tentative modification of the meaning of the term 'ether'. For the majority, 'space with physical qualities' was now an entity—a structural entity associated with time and capable of transmitting electromagnetic radiation.

The faulty line of reasoning which led to this hypostasy of space proceeded partly from a misunderstanding of what happens when we make physical measurements. Every physical measurement is a measurement of some physical quality—some mode of existence or mode of behaviour of matter. A physical quality is a form, state, process, tendency or relationship of matter. Measurement defines an amount of the quality con-

cerned by comparison with a standard quantity, as B. Riemann pointed out in his famous paper of 1845. For example, when we measure the quality of inertia, we define its quantitative aspect in terms of mass. The mass of a body is the quantity of its inertia compared to a standard quantity of inertia, e.g. a mass of one gram.

Physical space consists of spatial relations which are defined numerically by means of a measuring rod. What is the physical quality which we measure with the standard metre or yard rod, and analyse geometrically into spatial relations? As Descartes emphasized, this quality is *extension*. A measuring rod serves as a standard quantity of extension—a spatial unit—for defining other quantities of extension numerically.

Extension is a universal mode of existence of matter—a universal physical quality. Statically or dynamically, everything is extended in one form or another. When we analyse extension geometrically we obtain spatial relations. When we measure extension with standard rods we define spatial relations numerically. *Space is thus the quantitative aspect of extension, as far as physical reality is concerned.*

Mathematically, spatial relations may be treated as pure abstractions, and a number of purely mathematical spaces have thus been constructed. Whether any particular mathematical space represents the actual spatial relations of the physical world is determined by observation and experiment. Descartes' method of using co-ordinates to define spatial elements numerically permits a mathematical description of space, without reference to the quality of extension on which Descartes himself laid such stress. Gaussian co-ordinates, moreover, permit a mathematical description of space without reference to any material body. And in relativity theory even the measuring rod shrinks to a pure abstraction—an infinitely small, absolutely rigid and freely movable ideal rod. In relativity theory, spatial and temporal relations thus appear stripped of everything except the gravitational field, and are presented jointly as an *entity*, the space-time continuum. Somewhat intoxicated with mathematical success, physicists have failed to recognize, with Descartes, that space is the general quantitative aspect of the extension of matter, or, with Lobachevski, that time is the general quantitative aspect of motion.

Descartes emphasized that spatial dimensions are magnitudes of matter's extension. In the nineteenth century the materialist

mathematician Hermann Grassmann developed this idea, and recently the lead of Grassmann has been followed by H. G. Forder in his *Calculus of Extension*.

On a cosmic scale, physical space is the quantitative aspect of the gravitational field's universal extension. But the gravitational field is not yet regarded by physicists as a material structure, nor is cosmic space generally recognized as the quantitative aspect of the gravitational field's extension.* On the contrary, the gravitational field—and the fields of electromagnetic radiation—are commonly described as structures of *space*—or of space-time! Making the assumption that matter consists only of discrete particles, physicists hypostasize space, or space-time, into a distinct entity.

As against this metaphysical elevation of space to the status of an entity, modern materialism gives a dialectic interpretation of field phenomena. Defining matter as that which exists independently of human thought, we recognize the material character of the gravitational field, and of interpenetrating electric and magnetic fields. From this materialist point of view, fields and particles represent two fundamental and interpenetrating states of matter—the incorporeal state, represented by fields, and the corporeal state, represented by electrons, protons, neutrons and other particles. The quantitative aspect of matter's extension in these two fundamental states is physical space.

Those who object that this concept clashes with the result of the Michelson-Morley experiment and allied observations are thinking along out-of-date mechanistic lines. The non-corporeal continuous structure of physical fields excludes the mechanical phenomena which were formerly expected in connection with motion relative to the ether. Our materialist standpoint is based upon the findings of relativity physics. Experiments fail to show any motion of material bodies relative to surrounding physical fields because these fields are *continuous* structures, alternating in the case of radiating electromagnetic fields to give the constant velocity of light. Translatory motion exists only between *discrete* physical structures. Translatory motion of a body relative to surrounding continuous fields does not exist.

Current orthodox theory endows cosmic space with a capacity for transmitting light. Instead of the ether, space itself is now

*The late Professor Eddington maintained the possibility of empty space existing apart from the gravitational field!

endowed with 'the physical property of transmitting electromagnetic waves' [25]. Unwilling to enlarge their concept of matter to cover physical fields, and unable to postulate any longer an ethereal medium filling space, physicists are obliged to regard space as a 'medium' for the passage of light. From the toils of this hypostasy of space into a separate entity distinct from matter, there is no escape except through dialectic materialism. Only when particles and fields are seen to represent two interpenetrating states of matter—corporeal and incorporeal—is it possible to escape from the present insoluble contradictions of theoretical physics.

To take one illustration of this: the fusion of two particles of matter, an electron and a positron, results in the disappearance of both particles' with the production of electromagnetic radiation (two photons of radiant energy). From our materialist point of view, this is a case of matter changing from the corporeal to the incorporeal state in a process of energy transformation. From the mechanistic point of view of orthodox physics, however, matter is 'annihilated' when the two particles fuse themselves out of existence to give two photons of radiant energy. Conversely, a 'materialization' of energy is said to occur when an electron and a positron are formed from a quantity of radiant energy. Matter and energy are therefore sometimes spoken of as fundamentally 'identical', since material particles and energy quanta are mutually transformable in accordance with Einstein's equation ($E=mc^2$). Harold Spencer Jones, Britain's Astronomer Royal, has said that 'matter and energy are really synonymous terms'.

Energy, however, resides in all physical fields. What is commonly called 'empty space' consists of stores of energy, namely gravitational, electric and magnetic fields. These energy-storing fields are material in character if matter and energy are indeed 'synonymous terms'. But this conclusion denies the main premiss of theoretical physics, namely the assumption that matter consists only of discrete particles!

It is impossible to abandon the assumption that matter consists only of discrete particles without entailing a radical revision of basic scientific theory. Hence this assumption remains a burden on science progress, obstructing the formulation of new principles and producing insoluble contradictions among old generalizations. Yet wave-mechanics (most non-mechanical of theories!) has already shown that material particles are by no means

absolutely discrete bodies. A stream of electrons that passes through a thin sheet of metal on to a photographic plate gives a picture of concentric diffraction rings, due to interference of the electron waves

First demonstrated by Davisson and Germer in America and by G. P. Thomson in Britain, the wave structure of electrons and other particles has been subjected to many measurements. 'An electron moving at the speed of a rifle bullet has a wave-length of about a thousandth of a millimetre' [26]. Electron waves are actually used, in the electron microscope to see otherwise invisible objects. Protons and other particles have likewise been shown to have a wave structure.

Unencumbered with false premisses concerning the fundamental structure of matter, we have no difficulty in recognizing electron waves as dynamic material structures. Physicists, however, clinging to the obsolete idea that matter consists only of discrete particles, seek vainly for a non-material 'medium' to account for the passage of electron waves. W. Heitler, professor of theoretical physics in the Dublin Institute for Advanced Studies, has written: 'We have seen that a beam of electrons must be described "partly" as consisting of a number of individual particles and partly as a wave. . . . Speculations as to what the "medium" of the wave is have proved fruitless' [27].

In so far as an electron or other particle has a wave structure, it lacks the *absolute* discreteness once attributed to every material particle. Electron waves are not confined within a certain fixed radius, but diffuse so as to give an indefinite character to the size of the electron. An electron is limited in size by the distribution of its energy rather than by any boundary of its extension. 'It would seem as though for an electron the size was nothing but the region in which it exerted force, that this region has no very definite boundaries and may be larger or smaller according to circumstances' [28] (G. P. Thomson).

The same lack of absolute discreteness is seen in the structure of an atom, the nucleus of which is surrounded by a 'cloud' of electrons. 'An atom has no rigid boundary. It is impossible to draw a sphere around the nucleus, which just contains the electrons bound to it' [29] (W. L. Bragg). An atom 'cannot be regarded as possessing any sharp bounding surface' [30] (W. Hume-Rothery). Hence, in the words of the physicist P. Debye, 'it is very difficult, and the difficulty is immensely increased by the new conceptions of wave-mechanics, to say exactly what

we mean by the outside of an atom'. That is to say, an atom is not an absolutely discrete structure, since it is not absolutely discontinuous with surrounding fields. Physics maintains that particles are material structures and that fields are non-material. Yet there is no hard-and-fast line—no definite physical division—between a material particle and fields surrounding it!

Wave-mechanics is thus tearing to shreds the mechanistic premiss that matter consists only of discrete particles, absolutely discontinuous with one another in so far as they are separated by non-material fields. This premiss, which still remains a basic assumption of theoretical physics, is further weakened by the discovery that mass is common to fields and particles. The quality of inertia, measurable in terms of mass, was formerly thought to be confined to material bodies. Now, however, mass is known to belong to field structures no less than to particles and larger bodies. The mass of radiating electromagnetic fields gives light a certain momentum, so that a beam of light falling on a solid body exerts a slight but definite pressure. Mass, which is the quantitative aspect of inertia—a material quality—is common to particles and fields.

'The real unity of the world', wrote Friedrich Engels, 'consists in its materiality' [81]. Particles and fields are material structures whose interpenetration constitutes particle-field systems. The real unity of the world is a material unity of particles and fields. This material unity, the physical world, 'is not to be regarded as a complex of ready-made things, but as a complex of processes' [32]. Greatest of all questions concerning the universal complex of material processes is the question of motivation. If matter is essentially inert, what motivates matter? The reply of physics is—energy.

Energy is presented in physics as a non-material 'something' whose endless transformations underlie all physical processes; a non-material entity whose association with inert matter is responsible for physical change. Dialectic materialism lifts us above this creaking concept of inert matter and non-material energy. Modern materialists seek no cause external to matter in accounting for the motion of matter. Matter is self-motivated. Matter includes not only the quality of inertia, but also an opposite quality, measurements of which define quantities of energy.

Let us repeat at this point: a physical quality is a mode of existence or mode of behaviour of matter, that is, a tendency,

or a state, or a form, or a process of the material universe. A physical measurement defines a part, i.e. a quantity or quantum, of some physical quality. Quantities are defined numerically by adopting a particular quantity as a standard unit of measurement. The question is: what quality do we measure when we define energy numerically? Energy is admittedly a quantity. But a quantity of *what*?

Measurements defining energy numerically must be measurements of some *universal* quality. Since energy is an expression of actual or potential change, this universal quality must be a change-producing quality, opposite in character to the quality of inertia. To this measurable quality opposed to inertia, this universal tendency to physical change, we may apply the term *motivity*, whose dictionary definition is 'moving or impelling power'.

Quantity of motivity is energy. Energy is not an entity distinct from matter. Energy is the quantitative aspect of matter's general and inherent tendency to be active. The term *energy* was indeed coined by Thomas Young from the Greek word, *ἐνεργός*, meaning 'active'.

Motivity and inertia are two general modes of existence of matter. These two universal physical qualities interpenetrate one another to form a dialectic unity of opposites. When we measure motivity we define energy numerically. When we measure inertia we define mass numerically. The dialectic unity of motivity and inertia is expressed in the numerical equivalence of energy and mass, in accordance with Einstein's equation.

$$E = mc^2$$

where E represents energy, m is mass, and c is a constant (the velocity of light *in vacuo*).

This equation may be written

$$\frac{E}{m} = c^2$$

from which it is evident that the ratio of energy (quantity of motivity) to mass (quantity of inertia) has a constant value, c being a numerical constant (3×10^{10}).

The numerical constant c , which is the ratio of the electromagnetic unit of charge to the electrostatic unit of charge, is the velocity of light *in vacuo*. Evidently the constancy of light's velocity is a quantitative expression of the dialectic relationship between motivity and inertia. This relationship finds another expression in the acceleration of material bodies.

The essence of acceleration is the 'overcoming' of a body's inertia by a transfer of energy, producing a change of the body's velocity. The greater the body's mass (amount of inertia), the greater the energy (amount of motivity) required for a given acceleration.

Relativity theory shows that a body's mass increases with acceleration. As the velocity of a body increases, more and more energy is therefore necessary to overcome the body's increasing inertia and maintain its acceleration. This proportional opposition of change-resisting inertia to change-producing motivity places a maximum limit on a body's velocity.

The dialectic character of the opposition between motivity and inertia is seen in the so-called 'annihilation' of matter and 'materialization' of energy. When a particle of matter is transformed into radiation, its mass becomes radiant energy. That is, a quantity of inertia becomes a quantity of motivity. Conversely, when radiation is transformed into a particle of matter, a quantity of motivity becomes a quantity of inertia.

This does not mean that mass and energy are 'identical'. Mass is quantity of inertia. Energy is quantity of motivity. Motivity and inertia are dialectically opposed physical qualities, mutually transformable in accordance with the equation

$$E = mc^2$$

Energy and mass are thus *equivalent* quantities.

Inertia, in so far as it is transformable into motivity, may be regarded as 'latent' motivity. That is, mass may be considered as 'latent energy'. The total energy of a closed system, including the 'latent' energy or mass, remains constant. In other words, energy is conserved. In reality, however, this total energy which is conserved is the quantitative aspect of a dialectic unity—the unity of motivity and inertia. The principle of the conservation of energy may therefore be stated as follows: in a closed system, the dialectic unity of motivity and inertia remains constant in amount.

A few words in conclusion on the self-motivation of matter. Physics at present allows us to choose between blind chance and some supernatural power for our fundamental interpretation of the changing universe. Modern materialists reject this arbitrary choice. The standpoint of dialectic materialism is high enough to give a wider view of the universal complex of physical processes which we term *matter*. Especially in need of this wider view are biologists who find that the 'last word' of physics is

quite inadequate to account for the general behaviour of living matter.

The evolution of living matter and the astounding facts of recent embryology are fundamentally incomprehensible without a recognition that matter is self-motivated. 'Inert matter moved by non-material energy' is a hopelessly inadequate concept for a rational and comprehensive interpretation of biological phenomena. Dialectic materialism, in one respect a science of the sciences, awaits a conscious, formulated and tested application in the interests of biology; that is to say, in the interests of humanity. Utilizing the principles of modern materialism, biologists can prepare formulæ even more significant than those of the atomic bomb.

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